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SCIENCE AND ETHICS

THE symposium on the relations between science and ethics, published in *Nature* of September 6, is undoubtedly useful as well as interesting, though far from conclusive. In view of the present burst-up of civilization and the heart-searchings thereby caused, the subject is of immediate and universal interest. We may be sure it will not be claimed for the discussion in *Nature* that it has exhausted all possible points of view; and this article is intended to indicate another line of thought for examination by scientists. But we must first furnish a summary of *Nature*'s symposium.

Dr. C. H. Waddington, a biologist, has initiated the discussion with the thesis that "ethics is based on facts of the kind with which science deals;" that "science is in a position to make a contribution to ethics;" that science's contribution is "the revelation of the nature of the character and direction of the evolutionary process in the world as a whole, and the elucidation of the consequences, in relation to that direction, of various courses of human action". This thesis Dr. Waddington seeks to base on the findings of Psycho-analysts, Anthropologists, Marxists and Logical Positivists. Their findings are together taken to indicate that "all characters are both inherited and acquired; that they are products of the interaction between the genes, which we usually consider internal, and the equally necessary factors, such as oxygen, nourishment, etc., which we usually consider external"; "that the origin of the propositions of ethics is the observation that the world is such, and the personality is such, that the individual must follow certain rules". The super-ego within and conditions of existence without have till now

been responsible, jointly and leaving no room for any other factor, for our rules of conduct called morality, ("super-ego" being the name given by psycho-analysts to what they suppose to be a fetishistic power—a god, a conscience, or an indeterminate something which may be a complex of many things and derives authority not from the known world). "No criterion external to the natural world is required to decide what is the 'good' direction of the evolution" of society. "An existence which is essentially evolutionary is itself the justification for an evolution towards a more comprehensive existence."

We are afraid the lay reader must complain, as indeed many of the participators in the debate have done, that Dr. Waddington's method of presentation has not served to bring out his point, whatever it is, very clearly and precisely, or to make his argument compulsive. It is surprising that in formulating a new theory in a matter of such vital significance, Dr. Waddington should have, firstly, placed unqualified reliance on sciences which are still in experimental stages and very far from being definitive; secondly, omitted to check their evidences in the light furnished by the many other pertinent witnesses that there are, such as physicists and chemists on one side, and metaphysicians, normal psychologists, poets, theologians, historians and so forth on another. He has, in his book on *The Scientific Attitude* (pp. 62–63), admitted that science has not yet come to speak with a unitary voice, that her tongues are many and therefore confusing. It should have occurred to him that science would be assuming too much responsibility in trying, at this stage, to lay down final dicta on the ultimate questions of life and destiny. Indeed, his very first premise,—that "ethics is based on facts of the kind with which science deals,"—is not easy to grant. Facts of science are only a part of the universe with which ethics is concerned. There are other facts and factors of intimate concern to ethics which are not available to the microscope and the test-tube.

The Bishop of Birmingham raises questions as to the soundness of some of the fundamental assumptions of Dr. Waddington. He asks:—"If an external world exists, is our picture of it correct? ... Are our scientific laws accurate?" His answer is that the ethical standards we employ are, like our supposed knowledge of the universe, partial and transitional. He asks in conclusion:—

"Are we wrong to find purposive activity behind the processes of change called evolution, to postulate God as its source, and to see in the ethical change which results from the growth of human experience His progressive revelation of Himself?"

The Dean of St. Paul's is even clearer in his dissent. He says:—If Dr. Waddington's point is that "the natural sciences have a valuable contribution to make to the study of ethics, few would deny it; if it is, as I think, the contention that the central problem for ethics can be solved by the method of natural science, that seems to me a disastrous error." The Dean's view is that "the moral experience in its authentic form is the opposite of compulsion" and that there is a responsibility of choice belonging to man. He is further of the view that there is "no reason to suppose that at any given moment, the actual direction of evolution is towards higher values", and

that "the voice of duty comes from a Source deeper and more intimate than the course of evolution."

Prof. W. G. deBurgh is categorical in his denial of the authority of the sciences relied upon by Dr. Waddington.

Biology knows nothing of the qualitative distinction of higher and lower, better and worse; it can only display the continuity in the modifications of species through descent. ..... The cosmic process is wholly amoral. ..... The scientific study of it cannot teach us what is good or what we ought to do..... It cannot tell us that what will be is right or good.

Prof. C. E. M. Joad adduces an evidence strangely ignored by Dr. Waddington.

The real agents of ethical change are to be found less in the factors of external nature or of economic motive (Marxism) than in the appearance of an ethical 'sport' in the shape of a Christ, a Buddha, a Socrates or a Blake who points the way to new levels of conduct and new standards of value.

Other dissentients from Dr. Waddington's view are Prof. L. S. Stebbing, Prof. A. D. Ritchie, and Prof. H. J. Fleure. Professor Stebbing says—"It is not compatible with Dr. Waddington's 'realist definition' of 'good' to speak of the course of evolution as morally offensive or morally admirable". Prof. Ritchie holds that by reason of its method, "the only values within the scope of science are truth and error as judged by logical consistency and conformity to fact." Dr. Waddington's theory "rests on *a priori* pre-suppositions, which it is best to be honest about" having regard to the limitations of the values of science just indicated. Prof. Fleure points to the unacceptability of Dr. Waddington's proposition that "to decide what is the 'good' direction of evolution, no criterion external to the natural world is required." Dr. Fleure's view is this:—

Man is a social being and, within society, there is an unceasing and not always successful struggle towards freedom of conscience, towards replacement of external by internal factors..... The survival value of this freedom is related to the facts of observation and inference ..... Life's history on earth has been a process of ever recurring readjustments; and, with few exceptions, the fate of those forms which did not readjust has been extinction..... These developmental adjustments are selective; if some features are enhanced, others are atrophied. So, it is not very wise to suggest that the latter include the earlier; that unduly simplifies the idea of change and suggests acceptance of the rather crude notion of the inevitability of progress.

The last contribution to the debate is that made by Prof. Julian Huxley, a biologist. He points out how sciences not taken into account by Dr. Waddington have contributed to the breakdown of traditional views on ethics.

Evolutionary biology is one of them with all its implications as to human ancestry, the struggle for existence and the abolition of the idea of purpose in evolution. All the physical sciences have contributed, by providing a mechanistic explanation of natural phenomena previously attributed to supernatural powers and often invested with an ethical aura.

He agrees that it is possible to develop a new ethic, and to extend the categories of moral duties, in the wake of the extension of knowledge of nature which science achieves. But Prof. Huxley does not accept the theory of super-ego as an explanation of "certain aspects of morality which are felt as a categorical imperative." These aspects of morality he would appear to attribute to repression in early life.

A great part of our ethical development will consist in demolishing the absoluteness

and compulsiveness of our early categorical imperatives and in altering the field to which they apply, in the light of reason and experience. ..... For constructive and truly humanistic ethics, we need to liberate psychological energies from the unconscious repression of early life, through reason and still more by appropriate education and by opportunities for fuller living.

On the whole, Prof. Huxley endorses Dr. Waddington's thesis that—

> Ethical systems are indispensable social organs, derived from the impact of a changing external world on the minds of indivisuals *via* the social environment, but themselves then helping to effect changes in the external world and the social environment.

The discussion is of value as indicative of certain points of view. If it should have been more than that, one cannot help thinking that the writers ought to have been more lucid in their style, more comprehensive in their survey and more coherent in the marshalling of their arguments. One thing significant is that no one speaks in accents of certitude and no one seems to have anything positive to communicate. To say that they have adopted the tone of diffidence and are negative in their intimations is not to find fault with them, but rather to acknowledge that they are not lacking in frankness as to the limitations of their position. Bluntly stated, the position is that the data which science in its present state can furnish, including even the "exact" sciences, for a theory of ethics or metaphysics, are a field of quicksand. Nothing in science is now without an element of uncertainty. The laws of nature so far proved and established relate only to the upper strata of phenomena. That the ultimate questions are still a long way from a final and universally acceptable solution is proved, for example, by the controversy between Sir James Jeans and Sir Arthur Eddington in the pages of *Nature,* still being carried on over the meaning of a book by the latter published more than two years ago.* The lay student may perhaps hazard the remark that such inconclusiveness of science is its normal condition; that it cannot simply be helped; that science will indeed have ceased to be science when she has taken refuge in a dogma, and will have lost her occupation if she were ever able to feel that the journey's end has been reached and that there need be no more search by her; that she can serve us best only by remaining a diligent seeker and truthful reporter for all time. The best that she can ever hope to contribute is not definitive conclusion, but material,—verified and logically assembled material,—for some other agency to formulate conclusions thereupon so far as the deeper problems of life are concerned. Such problems are mainly the concern of ethics and metaphysics. They have constantly to re-examine their positions and correct them in the light of the evidences of science. The proper office of science is thus that of a witness; not that of the judge. When science assumes the role of the judge, it takes upon itself responsibilities for which it is not, according to its own admitted nature, fully equipped. When scientists have the frankness and the modesty to acknowledge this limited jurisdiction of their study, they will have ensured to science a

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* (1) "The Philosophy of Physical Science" by Sir A. Eddington. (Published in October 1939 by the Cambridge University Press.)

(2) *Nature*, August 2 and 30, 1941 (Nos. 3744 and 3748).

readier welcome into the court, and thereby enhanced her contribution to the making of philosophy.

The one point that emerges with general approval from the discussion in *Nature* is almost a commonplace. It is that ethics will be faced with new problems as science goes on creating new situations or disclosing new facts from beneath the covering of old situations, and that morals will have to go on evolving accordingly, as they have gone on in the past. In other words, science too has a part to play, and does play a very conspicuous part, in the evolution of morals. No one will dissent from this proposition. Science, indeed, is entitled to play such a part, and the people who deny this title to her will do so at grave peril to themselves.

But the fundamental question is:—Where is it that the moral sense has its origin? Is that sense merely the offspring of temporal calculations of convenience and comfort for oneself; or is it part of the essential nature of man—of that which constitutes humanness? Is it intrinsic or extrinsic? Which is the locus of the seed of morality? Is it the super-ego? Or is it external nature? Or is it a third something? Where so many earnest minds are busy inquiring and examining, we may perhaps be permitted to bring to their notice a view of life which is the most ancient view still living in the world, namely the Hindu view.

According to one school of the Vedantic philosophy, the whole universe is instinct with life-potential. This is in various stages of dormancy or of awakenedness. There never was a time when the life-potential did not exist, and there never will be. When this eternal life-potential manifests itself in man, it releases in him certain primary propensities or impulses (*vasanas*). In these impulses (*Samskara-vasanas*) brought forward from a previous state of existence of the man, lie hidden the forces of both altruism and egoism, of both social and anti-social behaviour. It is on this primary stuff that environment works. But the *vasanas* or impulses are not all alone. With them is associated a reasoning intelligence in shaping man's further career.

It is necessary to explain that a great many impulses or *vasanas* are a matter of inheritance, and that heirship itself is not a matter of accident, but one of inexorable law. A man's ancestry and also his environment including even what appear to be accidents, are determined by the logic of his previous incarnations. It is this inscrutable logic that is called the law of *Karma*. This explanation of the origin of *vasana* or impulse must obviously take us beyond the province customarily recognised by science as her own; it takes us to the land of the unprovable, the land of faith. Indeed, without the acceptance of the postulate of a *Tertium Quid* and its mysterious working, the philosophy of the Hindu would have no legs to stand upon.

Having postulated a mysterious Third Agent who, without revealing his own nature fully, enters into the life of man and of Nature, and having also postulated a law to explain ancestry and environment, the Hindu philosopher holds that man, nevertheless, has a range of freedom for his own discrimination and choice as to right action. The field of man's free action is bounded on the one side by the residual forces of his beginningless past, and on the other

side by the immeasurable forces of the cosmic sport behind which stands the Great One (*Brahman*). So situated, he has to find out that which is "good" by his own intelligence and achieve it by his own effort.

There is a duality in the composition of man: an outward impulsion and an inward impulsion. The flow and interplay of these two forces is human life. They mould character and make history.

The outward impulsion (*Pravritti*) takes the form of the thousand and one hungers of the body and the senses, and seeks their satisfaction from without. The investigation of the possibilities and potentialities of Nature and the ordering of collective life as family and State are the incidents of that outward impulsion. Thus arise science and politics and economics and art.

The inward impulsion (*Nivritti*) takes the subtler form of the hungers of what is called the soul—of the ego or the "I" element—and seeks satisfaction in the shape of answers to questions about man's ultimate destiny and about the purpose of life, if there be any. Thus arise religion and the non-utilitarian nucleus of morality—the instinct for justice and pity and righteousness, —and philosophy.

Of course the two impulses, as they proceed from a common centre, relate themselves to it constantly. They interact between themselves, leading to a mutual modification or intensification.

The outward urge, being the grosser and the more easily satisfiable, acts more quickly and more commonly than the other. The inward urge is ordinarily slower and less insistent.

Viewed from an absolute standpoint, the antinomy between the outward and the inward is a mere seeming; and beneath this seeming lies the reality of the *Tertium Quid* (the *Atman* or *Brahman*) transcending all; and the realization of it abolishes all distinction between the two,—between the subjective and the objective.

The way to the finding of this *Tertium Quid* is through a constant effort to reach a balance between the external concerns of life and the internal, a condition in which neither hunger is starved and neither interferes with the reasonable satisfaction of the other. The attainment of this state of harmonious adjustment of both departments of life under a higher control constitutes the central problem of ethics and philosophy. The higher control is to be looked for from a constant practice of the presence of the *Tertium Quid*. Both impulsions then become disciplines for the soul. Such an attitude and way of life is *Dharma* or ethics.

The fields of man's outward search are for ever bound to remain incapable of yielding unqualified or lasting satisfaction; and to fix the eye exclusively on them is to remain for ever discontented and chafing. Nature has so unequally distributed her gifts over the earth, our hungers are so manifold and so prolific, and our powers of obtaining satisfaction are so diverse and uneven that we must always be prepared to find some part or other of the human family to be aggrieved and complaining of maladjustment. Such grousing is in the very nature of Nature. Man owes it to himself,—to the ethicizing element called conscience in the introspective impulse within himself,—to strive

for the correction of social maladjustments partly by conquering more and more of Nature's resources for the use of mankind and partly by enforcing more and more equity in the distribution of the means of welfare among men. Indeed, such persistent striving for the improvement of human conditions,—by means, among others, of scientific advancement and social reform,—is the way of strengthening and developing that instinct of altruism in ourselves which is an indispensable vehicle for the realization of what we have called the *Tertium Quid*. But we should take care not to let our concern for the outward become a burdensome preoccupation, making us forget the inward duty and diverting us from the higher path.

The outward struggle, if it is not to lead us to a morass of unending turmoil and frustration and despair, should be under the inspiration and control of the aspiration inward. And the inward movement, if it is to proceed undisturbed towards fruition, should let the outward struggle so proceed that it could bring new supplies of spiritual strength by wearing out the "I" sense and developing the sense of the "All". From individualism to universalism in practice is the way to the realization within the soul of the oneness of the individual with the universal—a realization which is not simply an intellectual or emotional accomplishment, but a transmutation of man's whole spirit.

To be alive both in and out; to bring the outward and the inward into harmony; to so regulate the outward that the inward may not become a void, and so develop the inward that the outward may not remain a burden—that is true culture and true progress. This is the central principle of right conduct or *dharma*. The forms of *dharma* are many. They grow and develop so as to fit circumstances. But the governing motive is approach towards the Brahman.

Dharma literally means "the bearer" or "the upholder". *Dharma* is that which upholds or supports life by making it good. It is to be applied to the entire field of life—both individual and collective, and relating both to the mundane and to what is other than mundane. Of the all-comprehensive scheme of *dharma*, what in English is called morality is an integral part. Morality is ordinarily conduct that affects others. But there are also parts or aspects of conduct which do not concern others, but concern oneself most intimately—one's own character and one's own mind. Even in these 'private' departments of conduct, there is need for *dharma* or correct principles. If one should realize throughout one's life—in every detail and at every point—that harmony and communion between the inner and the outer departments of life which is the *summum bonum* for man, it is imperative that one should constantly put oneself under a reasoned discipline. The less spiritual elements of one's nature should, partly by restraint and partly by persuasion, be trained into subordination to the more spiritual. This implies discriminating attention not only to the needs of the body, but also to the needs of the æsthetic and the intellectual sides of life. No human faculty need be famished provided it will be governed by *dharma*. Indeed it is conceivable that *dharma* may itself recommend that certain appetites should be kept satisfied

upto a point, so that the higher elements in the man's nature may be left at peace to develop and grow.

Dharma has a particularistic side as well as a universal side. The great laws of society and State including custom, convention, formality and etiquette are of the latter category. Under the former head, the general rules are to be interpreted or modified so as to suit peculiarities of individual circumstance (*Dharma Sukshma*). Striving to maintain the social order, to improve conditions of existence, to cultivate fortitude, to face misfortune, to seek and find joy in life;—study, struggle, adventure, achievement;—all these can be an experience and an education to the human spirit; and *dharma* therefore should direct and control them all.

The seed of *dharma* lies imbedded within the nature of every man, besides the *vasanas*. It is part of his very nature. It is Wordsworth's "stern Daughter of the Voice of God". It is quickened into life by intelligence, education and reason; and the freedom to bring his intelligence to its aid and service belongs also to man.

The end of *dharma* is the complete and uninterrupted possession of the vision of the unity of life—the unity underlying life's myriad forms and myriad aspects and running through all processes of growth and change. He who has in his soul captured the vision of this infinite and indivisible unity has outgrown self-consciousness. He knows neither "I" nor "you" nor "he". Everything is the All or One to him, his sense of his own "self"—*i.e.*, his own distinctness,—being lost in it. How can his activities thereafter be other than "good"? He is good without effort, because he has rid himself of the taint of "I". Loving kindness would ever flow from him spontaneously, like the breath in his nostrils. *Dharma* is the scheme of duties and disciplines which leads man to become merged in this grand unitary vision of the ceaseless cosmic play. So to lose one's self is to gain the peace of "the eternal deep".

Such in rough outline is the Hindu's conception of right conduct. Would Dr. Waddington trace it to biological evolution or economic history or psycho-analyst super-ego? The Hindu view can be sustained only if the postulate of a *Tertium Quid* besides Man and Nature be accepted; and if there is anything in science to preclude such a postulate, the ground of that preclusion has nowhere been made clear. Science may not herself need it; but life, which is larger than science, stands in need of it if it should be more than a race of blind mice terrified by the screams of lame cats themselves frightened by the sniffings of dumb dogs in a sunless wood.

Matthew Arnold has summed up the argument, as a philosophical poet would, in some lines addressed to a preacher:—

"In harmony with Nature? Restless fool
Who with such heat dost preach what were to thee,
When true, the last impossibility!—
To be like Nature strong, like Nature cool!
Know, man hath all which Nature hath, but more,
And in that *more* lie all his hopes of good.
Nature is cruel, man is sick of blood;
Nature is stubborn, man would fain adore;
Nature is fickle, man hath need of rest;
Nature forgives no debt, and fears no grave;
Man would be mild, and with safe conscience blest.
Man must begin,—know this,—where Nature ends;
Nature and man can never be fast friends.
Fool, if thou canst not pass her, rest her slave."

D. V. G.

ATOMIC VIBRATIONS IN CRYSTALS

BY

SIR C. V. RAMAN

THE theory of the specific heat of crystalline solids is considered from a new standpoint in a symposium of seven papers appearing in the *Proceedings of the Indian Academy of Sciences*, for November 1941. The introductory paper is contributed by the author and is followed by six papers in which the basic ideas there outlined are successfully applied to the explanation of the experimental data for numerous substances of relatively simple composition. The cases of diamond and white phosphorus are considered respectively by Mr. V. B. Anand and Mr. R. Norris. Mr. Dayal has two papers on the specific heat of metals crystallising respectively in the cubic and hexagonal systems. Dr. C. S. Venkateswaran considers the case of the alkali halides in a specially thorough fashion, while Mr. R. Norris discusses the data for crystalline quartz.

As is well known, Einstein laid the foundations of the quantum theory of specific heats in his classic paper of 1907 in which the specific heat anomaly presented by diamond was explained on the assumption that the atoms in the solid vibrate with a high characteristic frequency. At low temperatures, however, the specific heat of all elementary solids falls off less rapidly than is indicated by the Einstein formula if a single characteristic frequency be assumed.

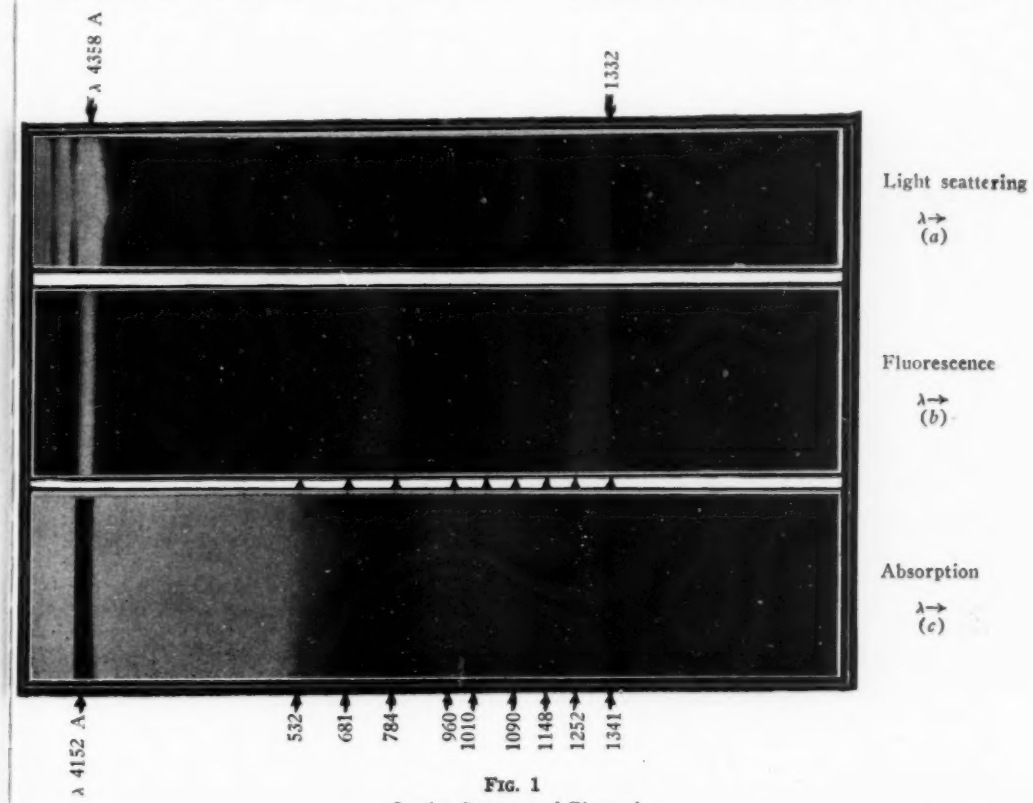

FIG. 1
Lattice Spectrum of Diamond

This was regarded as indicating a failure of the Einstein theory and led to its falling into disfavour. Discussions of the thermal energy data are at present usually based on the alternative theory propounded by Debye which derives its inspiration from the classical mechanics of vibrating elastic solids. Debye disregarded the discrete atomic structure of solids and assumed the atomic vibrations to be identical with the elastic modes of a continuum having various frequencies up to a suitably assumed high limit. An alternative form of the theory developed by Max Born and his school formally takes account of the crystal structure but has as its basis the so-called "postulate of the cyclic lattice". This postulate assumes that the external boundary of the solid determines all the possible modes of atomic movement exactly in the same way as in the classical theory of elastic vibration. The theories of Debye and Born are thus both based on an extrapolation of ideas derived from macroscopic physics into the field of atomistics. Such an extrapolation, besides being theoretically indefensible, leads to results which stand definitely contradicted by the experimental facts in many fields of inquiry. It is sufficient here to mention one example, namely the results of spectroscopic study of the scattering of light in crystals. Such studies show clearly the correctness of the original hypothesis of Einstein, namely that the atomic vibrations in crystals have *monochromatic frequencies*. Numerous sharply defined lines are recorded in the spectrum of monochromatic light diffused by transparent crystals, the frequency shifts observed being both greater and smaller than the so-called "limiting frequency" calculated from the elastic data (see Fig. 1).

The proper approach to the problem of atomic vibrations in crystals is evidently *not* from the macroscopic point of view, but from atomistic considerations which take as their starting point the known periodic space-grouping of the ultimate particles in the solid. What are the departures from the static grouping in space which are dynamically possible and what are their frequencies? In seeking an answer to these questions, we are justified, in view of the very fine scale of the atomic structure, in ignoring the existence of an external boundary and considering the solid to be of unlimited extension. On this assumption, it follows that the possible vibration patterns must be simply related to the architecture of the crystal. Any departure from the static grouping of the atoms will repeat itself with perfect periodicity in time only if it be also perfectly recurrent in space, in other words, only if the vibrations occur in identically the same fashion throughout the solid. The unit "cells" of the dynamic pattern must thus be either identical with the lattice cells of the crystal or else must embrace an integral number of such cells, thereby forming a superlattice. In other words, the atoms throughout the crystal occupying equivalent positions in the lattice or superlattice cells should oscillate in the same way. Such an oscillation would have a perfectly defined frequency, and the number of such frequencies would be determined by the number of atoms contained in each lattice cell or superlattice cell as the case may be. The larger the cell of the superlattice, the more completely would such an analysis (carried out in detail by the methods of the group theory) represent all the possible modes of atomic vibration in the crystal.

For the detailed development of these ideas, the reader may be referred to the papers appearing in the symposium. The thermal energy content of most crystals at ordinary temperatures depends almost exclusively on the modes of vibration which may be found by considering dynamic repetition patterns in which the space unit is the smallest which is fully representative of the structure and symmetry of the crystal. Even so, there would usually be several Einstein frequencies requiring consideration. In some cases, *e.g.*, diamond, phosphorus, alkali halides and quartz, these frequencies and the weights to be attached to them may be ascertained from the spectroscopic data and the known crystal structure. In other cases, *e.g.*, the metals, the specific heat data have themselves to be utilized to supplement the information furnished by considerations of crystal structure.

The principal lattice frequencies represent the movements of the atoms within the unit cell relatively to each other. They necessarily include the internal vibrations of any ions or molecules present in the lattice, as also the frequencies of their hindered translations and rotations. The superlattice vibrations which appear in the theory may be pictured as representing the oscillations

of neighbouring lattice cells or groups of lattice cells against each other. Such oscillations are necessarily of lower frequency and of lower statistical weight than the principal lattice frequencies. The contribution which they make to the specific heat would be sensible only at low temperatures, except in the case of crystals of very simple composition where they may have to be taken into consideration even at ordinary temperatures. The superlattice oscillations are the nearest analogue in the present theory to the elastic vibrations of macroscopic physics, but differ from them in being precisely related to the crystal structure and in possessing specifiable frequencies. That the existence of such vibrations is a physical fact and not a mere hypothesis is evident from the spectroscopic data for various actual crystals, *e.g.*, diamond (see Fig. 1).

The most significant point which emerges from the symposium is that the experimental facts in several cases which refused obstinately to fit into the Debye and Born theories find a natural explanation in the new theory without the aid of any special hypotheses.

RADIO RECEPTION DURING THE MAGNETIC STORM AND IONOSPHERIC DISTURBANCE FROM 17th SEPTEMBER TO 20th SEPTEMBER 1941

BY

K. VENKATARAMAN

(*Research Department, A.I.R.*)

SHORT WAVE radio services were very badly affected during the period 17th to 20th September 1941, due to a magnetic storm of severe intensity lasting for several hours and three sudden but short fadeouts of the Dellinger type. As published radio data from India on this subject is rather scanty and as such information may be useful for correlating world-wide conditions, it is proposed to present here the conditions of radio reception as reported by the various Receiving Centres of A.I.R. distributed throughout India, together with the results of pulse observations made at the main Receiving Centre at Todapur near Delhi.

The times of occurrence of the disturbances as far as can be estimated from *radio observations* are given below:—

(*a*) September 17, 1941: Sudden complete fadeout 1400^h–1425^h I.S.T.

(*b*) September 18, 1941: Sudden fadeout (partial) 0750^h–0819^h I.S.T.

(*c*) September 20, 1941: Sudden fadeout (partial) 0800^h–0850^h I.S.T.

(*d*) September 19, 1941: Magnetic storm effect—practically the whole day and night and up to 10 a.m. I.S.T. on the morning of 20th September 1941.

The times given for the commencement of the fadeouts (*a*), (*b*) and (*c*) are those noted at the Receiving Centre at Todapur and differ by a few minutes from those mentioned by the other A.I.R. Receiving Centres, which is mainly due to the sudden and unexpected nature of the phenomenon. The timings given for the end of the fadeouts are very approximate because of the varying duration of the fadeout on different frequencies.

The first three fadeouts can be easily identified as of the Dellinger type on account of the following characteristics:—

(i) The fadeouts occurred during daylight hours.

(ii) The commencement of the fadeouts was very sudden.

(iii) When conditions were returning to normal, stations working in the 16, and 19 metre bands were received before those working in the 25 and 31 metre bands.

(iv) Medium wave stations were not affected.

In addition to the above-mentioned fadeouts there was a severe ionospheric disturbance due to a magnetic storm of great intensity which occurred on September 18th and 19th.[1] The following particulars have been very kindly supplied by the Director of the Colaba Observatory, Bombay:—

[1] M. R. Rangaswami and A. S. Chaubal, *Curr. Sci.*, 1941, **10**, 432.

"Storm began at 9^h 44^m I.S.T. on 18th September 1941. Became intense between 10^h 20^m to $2\cdot^h$ 22^m on 18th September 1941.

Ended at 17^h I.S.T. on the 19th September 1941."

During the storm, it appears that there were brilliant displays of aurora in the northern and southern latitudes. Reports from the various A.I.R. Receiving Centres indicate that on the 18th September, excepting for a short Dellinger fadeout experienced in the morning, reception conditions were more or less normal, though a few Centres report that there was a tendency for flutter fading and weakening of signals. The worst day so far as radio reception is concerned was the 19th September 1941. The reception of European stations working on the 16, 19, 25 and 31 metre bands was very badly affected. Eastern stations were not markedly disturbed. The F_2 layer critical frequency decreases during a magnetic storm and as is to be expected the 31 metre band was less affected than the higher frequency bands such as 16 metres and 19 metres. It is interesting to note that at a time when no trace of the B.B.C. transmissions was to be had at Todapur, Bombay and Singapore seemed to be getting fairly good reception.

In the case of the Indian regional short wave stations operating in the 41 and 60 metre bands, the signal strength at places within the service area was not affected during the day or the night on the 18th September. But on the 19th September the signal strength of Delhi operating on 41 and 60 metres was found to be much below normal at Lahore and Lucknow, Calcutta on 41 and 60 metres was moderately reduced at Dacca, while Madras on 41 and 60 metres was normal at Trichinopoly. This interesting observation may mean either (1) that the effect of the magnetic storm in affecting the F layer critical frequency was not marked at the low latitudes of Trichinopoly and Madras, or (2) that, though the magnetic storm might have had its normal effect, the lowered value of the critical frequency might have been still high enough so as not to disturb the regional service from Madras.

Pulse observations made at the Receiving Centre at Delhi on a frequency of 7·2 Mc./s. on the afternoon of September 17th, showed normal returns from a layer height of 250 km. just before the disturbance but the returns completely disappeared during the fadeout period, no returns being observed even on 4·8 Mc./s. Just after 1425^h I.S.T., however, returns again appeared from a layer height of 250 km., showing thereby that during this period the F_2 layer ionization and height were not notably affected and that the disappearance of returns was entirely due to the increased absorption in the newly formed ionized layer below the E-region. During the partial fadeout on the morning of September 18th, returns were present but were extremely weak and the layer height did not alter appreciably.

Pulse observations were made on 7·2 Mc./s. from 0700^h to 2300^h I.S.T. on the 18th, 19th and 20th of September 1941. Reflections from layers at normal heights were obtained throughout the period of observation on September 18th, though the reflections were very weak for a brief period in the morning due to the Dellinger fadeout mentioned above. On September 19th however, there were no returns from 0700^h to 2300^h either on 7·2 Mc./s. or on 4·8 Mc./s. Conditions seemed to have improved by the early morning on September 20th and to have become fairly normal by 9^h I.S.T. on that day. These observations using the pulse technique correspond well with the observed reception conditions on the two days (September 18th and 19th, 1941).

An interesting observation is that ionospheric conditions were not markedly disturbed on September 19th up to 2300^h I.S.T. But according to the Colaba Observatory report, the magnetic storm had its maximum intensity on September 18th between 10^h 20^m and 20^h 22^m I.S.T., whereas ionospheric conditions were seriously disturbed during the whole of September 19th up to 2300^h I.S.T. (up to which time the observations were made). There appears to be no coincidence between the most intense period of the magnetic storm and the period of greatest disturbance of the ionosphere, at least so far as observations from Indian stations indicate. However, during the magnetic storm of 1st March 1941, there was close correspondence (as observed at Delhi and at other A.I.R. stations) between the two phenomena while radio reception in India was not markedly affected during the most intense period of the very severe magnetic storm of 24th March 1940.

OBITUARY

PROF. ALFRED JOSEPH CLARK, F.R.S.

MEDICAL SCIENCE in general and Physiology and Pharmacology in particular have suffered a heavy loss by the sudden death of Prof. A. J. Clark, Professor of Pharmacology in the Edinburgh University. He fell ill on the 26th of July 1941, and died on the morning of 30th July at Edinburgh, at the early age of 55.

A distinguished student of King's College, Cambridge, he took his B.A. in 1907 and graduated in medicine in 1910. His assistantship in Pharmacology at the University College, London, easily marked him out as a pharmacologist of exceptional brilliance and the high expectations about him were more than fulfilled when he successively held the chairs of Pharmacology in the University of Cape Town, University College, London, and University of Edinburgh. He succeeded Cushny as Professor of Pharmacology in the Edinburgh University in 1926, and quickly gained the reputation of being one of the most brilliant of British pharmacologists of his day. He became a Fellow of the Royal Society in 1931 and served as an active member of numerous scientific societies. He was on the Editorial Board of the *Journal of Physiology*, *Quarterly Journal of Experimental Physiology*, *Journal of Pharmacology* and *Experimental Therapeutics* and several other continental journals of Pharmacology and the pharmacological adviser to the *British Medical Journal*. He saw active service in the last War and was awarded the M.C. and during this war also he was in France and Flanders during the German drive in the last spring. He was a member of the Medical Research Council from 1934 to 1938 and again from 1939 till the time of his death. Serving on the M.R.C. for more than one term is a rare distinction shared by only a few other scientists before.

Besides his scientific publications—many of which were published in the *Journal of Physiology*—Clark gave numerous addresses on scientific subjects and wrote four books which reveal his wide outlook and scientific acumen. His book, "Applied Pharmacology" has passed through several editions during the last 17 years and is equalled in its popularity only by "Applied Physiology" written by Prof. Sampson Wright. The book is a standard book in all English-speaking countries and has found a permanent place on the shelves of students, medical practitioners and research workers. "Action of Drugs on Cells" is a work of outstanding merit and is universally used as a reference book by physiologists and pharmacologists alike, and as Sir Henry Dale has said, 'is likely to have its most permanent effect on the progress of scientific thought and experiment'. "Comparative Physiology of the Heart" was the result of Clark's unequalled experience of the physiology of the heart and his latest contribution "General Pharmacology" written as a supplementary volume to Hefters Pharmacology, is a standard work as a reference book for pharmacology. Besides these books and publications Clark wrote some pamphlets at least one of which has a great significance for medical men and authorities in this country. The pamphlet 'Patent Medicines' in the 'Fact' series gives a vivid description of the problem patent medicines and the art of advertising have created in the modern world. The book has aroused considerable interest and has set medical and administrative authorities thinking seriously about the situation.

Sir Ram Nath Chopra created the modern school of pharmacology in India and it is significant to note that most of Sir Ram Nath's students went to Clark to study pharmacology and obtain wider experience in the subject. Clark had a very soft corner for Indians in his heart and had no racial bias of any kind. Centres of pharmacological research in Madras, Lahore, Calcutta, Patna and Bombay can all testify to the interest Clark took in Indian pharmacology and the enthusiasm he created in the minds of those Indian workers who were fortunate to spend a few years with him. The writer of this note had the good fortune to spend about four years with Clark, first as a student and later as his assistant and remembers numerous occasions on which Clark used to inquire about his past students and their research activities. Sincere, generous and kind hearted, Prof. Clark treated his students and colleagues with the greatest kindness and always tried his best to help them in their difficulties. B.B.D.

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THE HIGH PRESSURE CARBON BAND SYSTEM

JOHNSON AND ASUNDI[1] proved firstly that the so-called high pressure carbon bands formed a system whose final state was the same as that of Swan system and secondly that the emitter of the bands was the C_2 molecule. It has been suggested subsequently by Fox and Herzberg[2] that the bands do not form a new system but are part of the Swan system. The basis for the latter suggestion is not definitely certain; they seem to form a v'' progression involving only another excited vibrational level $v' = 6$, of that system. The following, amongst others, however, shows that this suggestion is not tenable.

In the course of an investigation on the spectra of gases excited by high frequency discharge we have observed that under certain conditions of discharge in a tube from which carbon is not excluded, only the high pressure carbon bands mentioned above are present with low intensity to the exclusion not only of all other bands of C_2 but also of the Swan bands. The following bands are registered on our plates taken on a glass constant deviation spectrograph, the figures in brackets indicating photographic intensities visually estimated:—

λλ 4368·8, 4680·2 5434·9, 5899·3, 6442·3 in A.U.

Int. (1) (2) (0) (2) (1)

If these bands really formed part of the Swan system we get the remarkable result, that high frequency discharge brings about a selective development of only a part of a system of bands. It has been observed by previous workers that certain entire system of bands may be suppressed by h.f. or different conditions of discharge and we have also observed such a selective action in some recent experiments[3] in the case of the band systems of the CO molecule. We, however, do not think that the selective development of only a single

excited vibrational level of a molecule can be brought about this way.

R. K. Asundi.
Devi Datt Pant.

Benares Hindu University,
November 1, 1941.

[1] R. C. Johnson and R. K. Asundi, *Proc. Roy. Soc.*, 1929, **124A**, 668.

[2] J. G. Fox and G. Herzberg, *Phys. Rev.*, 1937, **52**, 638; G. Herzberg, *Astro. J.*, 1939, **89**, 291.

[3] R. K. Asundi, Nand Lal Singh and Devi Datt Pant, *Proc. Ind. Sci. Cong. Asson.*, 1942, Baroda (in the Press).

THE ULTRA-VIOLET BAND SPECTRUM OF MERCURY IODIDE

In continuation of the work[1] on HgCl and HgBr bands in the ultra-violet the bands of the HgI molecule have also been investigated in the same region. The Class I system reported by Wieland[2] is found to consist of two systems, designated as α_1 and β_1 having a common final level probably a $^2\Sigma$ state. The interval between the upper states is found to be 766 cm.$^{-1}$ approximately.

A new system designated as Class A is obtained in the region λ2540 and is also assigned to the diatomic molecule HgI. It is considered as arising from an electronic transition $^2\Pi - {}^2\Sigma$ showing four component heads, P_1, Q_1, P_2, Q_2 resembling in its structure the Class II system of HgCl.[1] The electronic separation is 126 cm.$^{-1}$. The following vibrational constants for the three systems have been calculated.

	α_1 system	β_1 system	A system	
ω_e'	47·7	44·2	98·1	cm.$^{-1}$
ω_e''	55·5	55·5	92·7	,,
$x_e'\omega_e'$	·8	·4	2·4	,,
$x_e''\omega_e''$	·8	·8	2·0	,,
ν_e	38786·7	38022·1	39231·1	,,
V_{atom}	4·75	4·72	4·85	volts

Details of the structure will be published elsewhere.

M. G. Sastry.

Andhra University,
Waltair,
November 20, 1941.

[1] *Curr. Sci.*, 1941, **10**, 169, 197; and *Proc. Nat. Inst. Sci., Ind.* (in press).

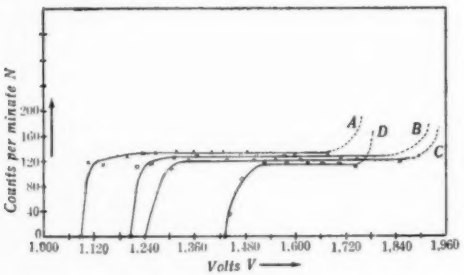
[2] *Helv. Acta Phys.*, 1929, **2**, 46, 77.

HELIUM-FILLED GEIGER-MÜLLER COUNTERS

We have studied the characteristics of G.M. counters filled with helium in admixture with various alcohol vapours at different partial pressures. The counter was made from pyrex glass with a copper cylinder (2·3 cm. diameter and 12·6 cm. length) inside and a nickel wire (0·1 mm. diameter) running along its axis. After assemblage the surface of the copper cylinder was treated successively with 6 normal and 0·1 normal nitric acid, washed with distilled water ten times and then dried. It was further heated with dry nitric oxide gas inside till the copper surface turned to a dark velvety colour. The helium used had been purified by means of activated charcoal at liquid air temperature. Vapours from ethyl, methyl, normal butyl, isopropyl and laboratory amyl alcohols have been used.

For each of the various organic vapours studied in admixture with helium a total pressure of 10 cm. in the counter was maintained while the concentration of the organic vapour was increased from a partial pressure of 0·5 cm. to 3·5 cm. in steps of half-a-centimetre. The liquid alcohol was kept surrounded by a freezing mixture to keep the amount of water vapour inside the G.M. counter as small as possible, in any case negligible as compared to the alcohol vapour inside. Starting with a 0·5 cm. admixture of alcohol vapour in a total pressure of 10 cm. it was found that the length of the plateau first increased with increasing proportions of the alcohol vapour, but

as the vapour pressure was increased beyond 3 cm. the plateau no longer remained horizontal but became an ascending one. We get the best plateau for the case of helium-methyl alcohol mixture (7 cm. + 3 cm.), for which the plateau extends over 400 volts. Helium-ethyl alcohol mixture also gives an equally good plateau, though the threshold potential is higher in this case. We give the characteristic curves showing the relation between N, the number of counts per minute and V, the potential applied on the wire of the counter for admixtures of ethyl, methyl, isopropyl alcohols and ethyl ether at the same partial pressure of 3 cm. This comparative graph shows that helium-methyl alcohol, and helium-ethyl alcohol are best suited for G.M. counter fillings.



A = Methyl Alcohol.
B = Ethyl Alcohol.
C = Isopropyl Alcohol.
D = Ethyl Alcohol.

It is also noticed that the threshold potential increases with increasing concentration of the organic vapour, which fact is also evident from the work of Trost.[1] We suggest that this increase in the threshold potential is due to the fact that the greater amounts of the organic vapour inside the counter decrease the effective mean free path for the ions by increasing their size considerably (both by condensation and formation of clusters) and thus necessitate larger fields to be applied to produce ionization by collision and initiate a discharge. Comparison with Trost's observations on argon-alcohol counters shows that for helium-alcohol counters the threshold potentials are consistently lower than for counters that are filled with argon and alcohol.

Details will be published elsewhere.

P. L. KAPUR.
H. R. SARNA.
CHARANJIT.

Physics Laboratory,
Government College, Lahore,
October 31, 1941.

[1] Trost, *Zeit. für Physik*, 1937, **105**, 399.

4-CO-ORDINATED MERCURIC SALTS WITH DIAMINES AND A NEW METHOD OF ESTIMATING MERCURY

IT is generally held that among the salts of mercury, only those of oxyacids are able, under suitable conditions, to form tetramine compounds. Substitution and hydrolysis, however, occur even in these cases. The incapacity of mercuric halides to combine with more than two molecular proportions of amines is attributed to their low degree of ionisation. Von E. Schering[1] has described bis-ethylene diamine mercuric chloride which is a four co-ordinated mercuric halide. The present author finds that such a compound does not exist in a pure form in the solid state. Both mercuric chloride and mercuric bromide are found to form with equimolecular proportions of ethylene diamine, white mono compounds which are insoluble in water. Though these dissolve in excess of the diamine and give water-soluble products, pure bis-ethylene diamine mercuric halides cannot by any means, be obtained from them. They are completely converted into insoluble mono compounds in the process of washing with alcohol or crystallisation from water. It has, however, been possible to prepare bis-ethylene diamine mercuric chloroplatinate in addition to bis-ethylene diamine mercuric salts of oxy-acids. The chloroplatinate is insoluble in water and does not change when kept in a desiccator over sulphuric acid for a long time. In fact, the stability of the compound is such that it becomes possible to estimate mercury accurately by a simple method. To alcoholic

solutions of mercuric salts, ethylene diamine is added in just sufficient quantity to dissolve the precipitate first formed. Aqueous ammonium chloroplatinate is then added to the solution obtained till the light yellow precipitate of the chloroplatinate ceases to be formed. The precipitate is washed thoroughly at first with water, then with alcohol and after drying in a desiccator over sulphuric acid, weighed as $Hg\ en_2\ Pt\ Cl_6$. It appears that mercury can also be estimated as bis-ethylene diamine chloroplatinite. Propylene diamine, it may be noted, can be used instead of ethylene diamine in all the reactions described above.

KANAI LAL MANDAL.

Chemical Laboratory,
Presidency College,
Calcutta,
September 15, 1941.

[1] Von E. Schering, *Chemische Fabrik, Auf Actien—D. R. P.*, 12095.

APPLICATION OF FRIES REACTION TO ESTERS OF HYDROQUINONE

FRIES reaction[1] has been successfully applied to esters of resorcinol and catechol. Numerous heterocyclic compounds (*e.g.*, coumarins, chromones, furo-coumarins, flavones, etc.) have been prepared from resacetophenone obtained from resorcinol. No work seems to have been done on corresponding derivatives of hydroquinone. However, oxygen containing heterocyclic compounds such as chromanes, coumarans and dihydrocoumarins have been prepared in large numbers, on account of their expected vitamin E activity, by the action of allyl halides or hydroxides on hydroquinone and its derivatives.[2]

In order to prepare the various oxygen containing heterocyclic compounds corresponding to hydroquinone, it was necessary to obtain the different ortho hydroxy ketones of hydroquinone. The simplest member, *viz.*, 2:5-dihydroxy acetophenone was found recorded in literature and was prepared by Nencki's reaction,[3] from hydroquinone, acetic acid and fused zinc chloride. The yield of the ketone was, however, very poor. Regarding the other method of obtaining the ketone, *viz.*, the Fries reaction, two workers have independently recorded negative results in the case of hydroquinone diacetate.[4]

On looking up the original paper of Heller[4] it was found that he had used ferric chloride in place of the more usual anhydrous aluminium chloride. This may, perhaps, have been the cause of his negative observation. Mauthner[4] used anhydrous aluminium chloride and still failed to observe the Fries reaction.

Although the usual experimental conditions recommended by Rosenmund and Schnurr,[5] for the Fries transformation, generally give satisfactory results in most of the cases it is my experience that in some cases, higher temperature, larger proportion of aluminium chloride and longer period for the reaction are necessary to bring about the Fries reaction. It was, therefore, thought worthwhile to try Fries reaction on esters of hydroquinone under modified conditions. The results have been successful, and satisfactory yields have been obtained in the case of hydroquinone diacetate and hydroquinone dibenzoate.

On heating hydroquinone diacetate m.p. 121° with anhydrous aluminium chloride a substance m.p. 202° was obtained in 76 per cent. yield. The substance m.p. 202° was identified as 2:5-dihydroxy acetophenone by direct comparison with a sample of the same prepared by Nencki's method (*loc. cit.*).

In the same way, hydroquinone dibenzoate m.p. 204°, on heating with anhydrous aluminium chloride, gave a substance m.p. 125° in 42 per cent. yield. The substance m.p. 125° was identified as 2:5-dihydroxy benzophenone by direct comparison with a sample of the same prepared according to the method of Bogert and Howells.[6]

All attempts to prepare the 2:5-dihydroxy benzophenone by Nencki's method failed. It is

interesting to note that by heating benzoic acid and hydroquinone in the presence of fused zinc chloride, mono- and dibenzoate of hydroquinone are obtained instead of the above mentioned ketone.

The work of extension of Fries reaction to other esters of hydroquinone and its derivatives, and of the use of the resulting ketones in the preparation of different heterocyclic compounds is in progress.

R. Y. SHAHANE.

Chemistry Department,
Sir Parshurambhau College, Poona 2,
October 8, 1941.

[1] Fries and Finck, *Ber.*, 1908, **41**, 4271.
[2] Smith, *Chemical Reviews*, October 1940.
[3] Nencki and Schmid, *J. Prac. Chem.*, (2), **23**, 546.
[4] Heller, *Ber.*, 1912, **45**, 2389; Mauthner, *J. Prac. Chem.*, (2), **149**, 324–27.
[5] Rosenmund and Schnurr, *Ann.*, 1927, **460**, 56.
[6] Bogert, and Howells, *J. A. C. S.*, 1930, **52**, 842.

THE FRIES MIGRATION OF THE ESTERS OF POLYHYDROXY PHENOLS

ORTHO as well as para hydroxy Ketones are important intermediates for the synthesis of a number of heterocyclic compounds and oxy-azo dyes. Therefore, any method that enables us to prepare them smoothly and conveniently is particularly welcome. A study of the application of the Friedel-Crafts and the Nencki Reactions by the author and his co-workers[1] has shown that it is not always possible to get the requisite hydroxy-ketones in good amounts by these methods. Therefore, we have now studied the Fries migration of the acetates and benzoates of orcinol, hydroquinone, pyrogallol and phloroglucinol, etc., under varying conditions of time, temperature and the amount of the catalyst ($alcl_3$). Some of the interesting results are summarised hereunder:

(1) Hydroquinone diacetate as well as dibenzoate gave good yields of 2:5-dihydroxy aceto-phenone and 2:5-dihydroxybenzophenone. This is thus the best method of preparing these compounds.

(2) Orcinol diacetate gave 2:4-diacetyl-orcinol which can be readily deacetylated to γ-orcacetophenone. This method of preparing γ-orcacetophenone is superior to that of Desai and Vakil (*loc. cit.*).

(3) Pyrogallol triacetate gave exclusively gallacetophenone (excellent yield).

(4) Phloroglucinol triacetate gave mainly 2:4:6-triacetyl, or 2:4-diacetyl phloroglucinol according to conditions, and phloracetophenone only in traces. The work is being extended to other esters.

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C. K. MAVANI.

The Chemistry Department,
St. Xavier's College,
Bombay 1,
November 20, 1941.

[1] Desai and co-workers, *Proc. Ind. Acad. Sci.*, 1938, **8A**, 194; 1940, **11**, 140, 149; **12**, 46, 392, 507; **13**, 33, 40, 132.
[2] Fries and Finck, *Ber.*, 1908, **41**, 4271.

THE APPLICATION OF THE NENCKI REACTION TO β-NAPHTHOL

BY the application of the Nencki Reaction to α-naphthol using lauric, palmitic and stearic acids, the authors[1] have got good yields of 2-lauryl-, 2-palmityl-, and 2-stearyl-1-naphthols. The same reaction does not take place smoothly with β-naphthol using lower fatty acids like acetic and propionic acids. Thus 1-acetyl-2-naphthol is not obtained in good yield on heating β-naphthol with acetic acid in presence of anhydrous zinc chloride, and the best method of preparing this hydroxy-ketone is the Fries migration[2] of β-naphthyl-acetate. We have now studied the Nencki reaction between β-naphthol and lauric, palmitic and stearic acids, and find that excellent yields of 1-lauryl-, 1-palmityl- and 1-stearyl-2-naphthols are obtained. The various chemical properties of these interesting hydroxy-ketones have been studied with a view to instituting a comparison

with their analogues. Fuller details will be published elsewhere in course of time.

R. D. DESAI.
W. S. WARAVDEKAR.

The Chemistry Department,
St. Xavier's College,
Bombay 1,
November 20, 1941.

[1] Desai and Waravdekar, *Proc. Ind. Acad. Sci.*, **1940**, **12A**, 507.
[2] Fries, *Ber.*, 1921, **54**, 709.

STUDIES IN INSECT NUTRITION: THE NATURE OF THE FAT-SOLUBLE FACTOR

IN an earlier communication it was pointed out that the rice moth [*Corcyra cephalonica*, Staint (Lep.)] requires a fat-soluble growth-promoting factor, as revealed by Table I.

TABLE I

Diet	Wt. of 10 larvæ in milligrams after a period in days		
	10	20	30
Whole cereal (Jowar) ..	8·6	75·8	170·0
Ether extracted Jowar + refined groundnut oil	1·6	3·5	5·0
Do. + Ether extract	6·8	67·3	145·6

With a view to determine the nature of the growth-promoting factor, the ether extract of Jowar, "Jowar Oil", has been investigated. The above figures suggested the probability of the growth-promoting factor being associated with the non-glyceride fraction of the "oil".

50 gm. of the Jowar "Oil" were saponified for 2 hours in an atmosphere of nitrogen. After saponification, the mixture was diluted with an equal amount of water, and the solution extracted six times with batches of 200 c.c. of ether. The ether extract was dried over anhydrous sodium sulphate for 24 hours and the ether distilled off in an atmosphere of nitrogen.

The residue was subjected to a second saponification adopting the above procedure and the non-saponifiable matter extracted with ether. The ethereal solution was assayed for its growth-promoting activity towards the larvæ of the rice moth (see Table II).

TABLE II

Diet	Wt. of 10 larvæ after a period in days		
	16	26	32
Whole Jowar ..	18·5	172·7	290·0
Ether extracted Jowar + refined groundnut oil	2·2	10·4	22·5
Ether extracted Jowar + non-saponifiable matter	8·44	99·0	175·0
Do. + refined groundnut oil	11·0	130·0	222·0

The results in Table II point to the conclusion that the factor gets concentrated in the unsaponifiable fraction of the oil.

The non-saponifiable fraction, which has been shown to contain the factor, was subjected to a further fractionation. Xanthophylls and the resin acids associated with the fraction were eliminated by washing the petrol ether solution of the unsaponifiable fraction with 85 per cent. methyl alcohol; the petrol ether layer retained the sterols and the carotenes. The two fractions were assayed employing the rice moth. The results given in Table III showed that the active factor was associated with the petrol ether layer.

TABLE III

Diet	Wt. of 10 larvæ in milligrams after a period in days		
	14	26	30
Whole Jowar .	14·4	177·0	250·0
Ether extracted Jowar + petrol ether fraction	12·6	170·0	248·0
Do. + alcohol fraction	1·8	7·7	10·7

The petrol ether fraction was further purified and the sterols crystallised, which on assaying, was found to possess the growth-promoting factor. The sterol crystals have an m.p. 75°–76° C. and a specific rotation of −17·76° (25° C. chloroform solution). Attempts at a further purification and identification of the factor are now in progress.

P. S. Sarma,
M. Sreenivasaya.

Indian Institute of Science,
Bangalore,
December 9, 1941.

A RAPID CHROMIC-NESSLERIZATION METHOD FOR THE ESTIMATION OF NITROGEN IN BIOLOGICAL MATERIALS

The applicability of the chromic oxidation method for the estimation of nitrogen in pure organic compounds as well as in natural plant and animal products, has been examined in detail by one of us[1] and it was shown that if suitable precautions be adopted, the method gives fairly satisfactory results in the case of soils, plant materials and composts. Since the method is simple and avoids the need for a special fume-cupboard characteristic of kjeldahl digestions, an attempt was made to further simplify the technique by omitting the subsequent distillation procedure for ammonia, so that even the supply of flowing water and of gas could be dispensed with, and it may become possible to carry out the nitrogen determinations even in places where such gas and water facilities may not be available. The aim was primarily to enable educated farmers, municipalities and village panchayats to determine the nitrogen content of their soils, composts and organic manures with simple equipment not involving the supply of gas and flowing water.

We have found that it is possible to devise a method satisfying the above conditions and giving results agreeing with the Kjeldahl values, by proceeding as follows:—0·2 to 0·5 gm. of the material taken in a test-tube is oxidized with 5 c.c. of chromic-sulphuric mixture for 5 minutes at 200° C. in a castor oil bath (heated by a wick-stove), after which the contents are diluted and the excess of chromic acid and traces of nitrate present are reduced by addition of sodium sulphite. The chromium is then precipitated by the addition of sodium carbonate to slight alkalinity, the contents are made up to a known volume and an aliquot filtered off for the estimation of ammonia by nesslerization.

About a dozen samples can be kept for oxidation simultaneously in test-tubes in the oil-bath and by use of tinted glasses showing ranges of nessler-colours, it is possible to carry out the above one dozen estimations in about 2 hours time.

Full details of the experimental procedure and results obtained would be published elsewhere.

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November 14, 1941.

[1] *Biochem. J.*, 1936, **30**, 241, 1026; *Nature*, 1935, **136**, 644; *cf* also *Proc. Ind. Acad. Sci.*, 1934, **1B**, 155; 1935, **28**, 213; *J. Soc. Chem. Ind.*, 1935, **54**, 34T; *J. Ind. Inst. Sci.*, 1936, **19A**, 45; *Curr. Sci.*, 1941, **10**, 261.

A NOTE ON THE "LEAD-RATIO" METHOD FOR DETERMINING THE AGE OF THE DECCAN TRAPS

The various methods that have been applied hitherto for the determination of the geological age of the Deccan Traps in India by different workers, are known to be based mostly on the stratigraphic as well as palæontological evidences derived from the fossil remains of the sedimentary beds (inter-trappean and infra-trappean) found in association with these traps. From the palæontological evidence the Tertiary age has been assigned to the Deccan traps.[1,2,3,6] On the other hand, stratigraphical evidences led various workers to attribute

either the late Cretaceous or early Tertiary period to these volcanic formations.[4,5]

A few years back an attempt made by us to determine the age of some specimens of the Deccan Trap (basic lavas) of Bombay and Salsette Islands by the "lead-ratio" method of the actual analyses of rocks for their uranium, thorium and lead contents, gave encouraging results as shown in the following table:—

Specimen and Slide	Name of the rock	Locality	Structure	Alteration	% Uranium	% Thorium	% Lead	Pb / U + 0·36 Th	Calculated age in millions of years	Geological Horizon
1	Andesine Andesite	From the seashore in the vicinity of the Indian Military Quarters opposite the Afghan Church, Colaba (18°–58½′ : 72°–49′)	A little coarse	Almost none	$20{\cdot}988 \times 10^{-2}$	Nil	$13{\cdot}531 \times 10^{-4}$	0·006	45·6	Oligocene
2	Andesine Andesite	From a small exposure, near Altamount Road, Cumballa Hill (18° 58½′ : 72°–48′)	Very compact	Slight	$21{\cdot}703 \times 10^{-2}$	Nil	$13{\cdot}531 \times 10^{-4}$	0·006	45·6	Oligocene
3	Basalt	Collected from a quarry worked at a distance of some yards to the west of the Goregaon Railway Station, Goregaon (19°–10′ : 72°–51′)	A little coarse	Slight	$11{\cdot}686 \times 10^{-2}$	Nil	$11{\cdot}598 \times 10^{-4}$	0·009	68·4	Lower Eocene
4	Basalt	Exposure in the low grounds of Borivli at a distance of about a mile to the east of the Railway Station, Borivli (19°–14′ : 72°–52′)	Coarse grained	Slight	$11{\cdot}686 \times 10^{-2}$	Nil	$8{\cdot}698 \times 10^{-4}$	0·007	53·2	Upper Eocene

In this table the specimens collected from Bombay and Salsette Islands are found to belong to the Tertiary period and their age results also indicate two distinct lava flows, one of 45·6 million years (Oligocene) and the other of about 60 million years (53·2 to 68·4 million years), *i.e.*, Eocene, corresponding to the two distinct flows of lava as postulated by Dubey[3] who remarks that "both kinds of basalt exist in Bombay, one of the early tertiaries and the other of the late tertiaries".

These indications are decidedly encouraging and justify our attempt in applying the analytical "lead-ratio" method for evaluating the age of the Deccan Traps. A careful scrutiny of the present-day literature shows that the method has not been applied so far to igneous rocks forming the Deccan Traps.

In applying the "lead-ratio" method we have determined the amounts of uranium, thorium and lead in fresh specimens by chemical methods. The percentage error is minimised by using large quantities, as much as 50 gm., in the uranium determinations. Further, the determinations of all the three elements (U, Th, Pb) have been carried out on the same sample. Considering that the amounts used by us in the chemical analyses are much larger than the usual 0·5 gm. or 1 gm. generally taken in an analysis, our data fulfils the high accuracy required for ascertaining the geological age. Errors due to alteration caused by outside agencies have been avoided by selecting the specimens far away from the weathered regions and also by carrying out the relevant microscopic study of the specimens.

From the results of our analyses we have calculated the age of the rocks from the following formula,[7]

$\frac{\%\ Pb}{\%\ U + 0{\cdot}36\%\ Th} \times 7{,}600$ million years, and have assigned geological epochs to the rock samples under investigation following the time division scale adopted by Barrel[8] and W. D. Urry.[9]

As regards the validity of the "lead-ratio" method as applied by us to these rocks, it is true that no objection can be raised against the method if the atomic weight of "rock-lead" is determined, for that would be conclusive evidence as to its presence by radioactive changes of uranium and thorium. Because of the small amounts of lead, the atomic weight determination by purely chemical methods is out of question. In future perhaps, the improved technique in the mass spectrograph will be able to establish the isotopic nature of "rock-lead" in which case the origin of "rock-lead" will no more be a moot point and the "lead-ratio" method will be safely applied for measuring the geological time. In spite of this limitation, the fact that our chemical results are supported by independent palæontological evidence has convinced us that "rock-lead" obtained during our analyses is of radioactive origin.

Arthur Holmes[10] points out that igneous rocks of volcanic origin contain uranium and thorium and are richer in these elements than the plutonic types. Besides, from the thermal consideration, it appears that the radioactive elements, uranium and thorium, have been systematically concentrated towards the outer part of the lithosphere.[11] Further, Dubey[7] has applied the helium method to the Deccan traps from Pawagarh Hills in Kathiawar which proves the presence of radioactive uranium in the Deccan traps. The presence of uranium is further confirmed by the results of our analyses. Considering the fact that the Deccan traps (basic lavas) are of volcanic origin, and that the specimens collected by us in Bombay and Salsette Islands come from localities where contamination by extraneous lead is not possible, we may be justified in assigning the presence of small amounts of lead found in our specimens as being of radioactive origin.

Further work on these lines from the geological standpoint has been carried out in the Department of Geology, St. Xavier's College, Bombay, and the results will be published when they are ready.

A. S. KALAPESI.
S. K. CHHAPGAR.
R. N. SUKHESWALA.

St. Xavier's College,
Bombay,
October 15, 1941.

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[1] Rama Rao, L., Narayan Rau, S. R,, and Sripad Rau, K., *Proc. Ind. Acad. Sci.*, 1936, **3.**

[2] Sahni, B., *Curr. Sci.*, 1934, **2.**

[3] " The age of the Deccan Traps," Section of Geology and Geography. *Abstracts of Discussions, Ind. Sci. Cong. 24th Annual Meeting*, Hyderabad, 1937.

[4] Fox, C. S., *Rec. Geol. Surv. India*, **62**, Pt. 1.

[5] —, *Curr. Sci.*, March, 1935.

[6] Rama Rao, L., *Proc. Ind. Acad. Sci.*, 1936, **4.**

[7] *Bulletin of the National Research Council*, No. 80, June 1931, Physics of the Earth—IV, the Age of the Earth.

[8] Wilmarth, M. Grace, " The Geological Time Classification of the United States Geological Survey compared with other Classifications," *United States Geological Survey Bulletin*, 769.

[9] " Report of the Committee on the Measurement of Geologic Time," Alfred C. Lane, Chairman: Presented at the Annual Meeting of the Division of Geology and Geography, National Research Council, April 27, 1935.

[10] Holmes, A., *Science Progress*, 1914, **9**, 12.

[11] Strutt, R. J., *Proc. Roy. Soc. London*, 1906, **77A**, 472.

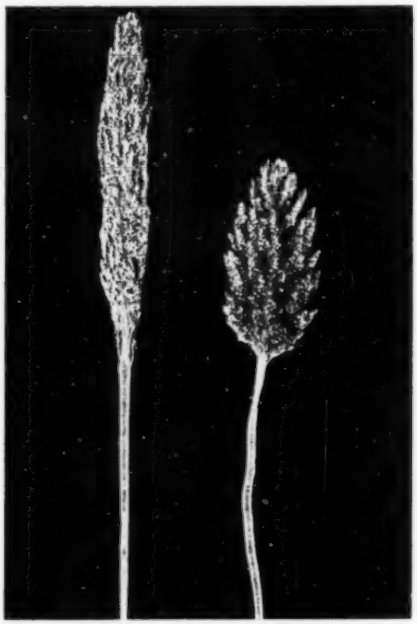
WAVY PEDUNCLE—THE BASIC CAUSE OF GOOSE-NECKING IN SORGHUM

GOOSE-NECKING occurs in some varieties of sorghum. These are mostly Asiatic and belong to the compact headed, short stalked *Durra* sub-series of grain sorghum. This phenomenon occurs in the American variety Milo which belongs to *Sorghum subglabrascens* of the *Durra* sub-series. In examining this character Conner and Karper[1] have observed that the tight inrolling of the top portion of the boot makes the panicle bend out in the place of least resistance giving rise to goose-

necking. Martin[2] records that the causes are thick heads and a narrow boot.

Experiences gained at the Millets Breeding Station, Coimbatore, have helped to throw more light on this phenomenon. It has been noted (1) that big heads that are not goose-necked are common, (2) erect peduncles occur in both big and narrow boots, and (3) with impediments to emergence there have been isolated cases of long peduncles with goose-necking.

In a fodder type of *Sorghum sudanense* received from Odessa in the U.S.S.R. there occurred a type whose peduncles were not straight but very broadly wavy. This type



Straight peduncle Wavy peduncle

was e-ligulate and had therefore a compact panicle.[3] In a few cases where the emergence of the tiller head was poor there occurred goose-necking. This suggested a possible connection between the attribute of waviness of peduncles and the manifestation of goose-necking. An examination of the wide sorghum collections showed that the waviness (which may vary from noticeable undulations to a very shallow disturbance which can be easily felt when the stalk is passed between fingers) occurs in some of the types of cultivated sorghum (photograph).

In pure lines it was noticed that in wild sorghums with the exception of the above mentioned *S. sudanense* type only the *Para sorghums* tended to have wavy peduncles.[4] In cultivated sorghums this character was common in the types belonging to the *Durra* sub-series. Waviness could exist both in long and short peduncles. When the peduncle is long (emergence is good) the wavy factor does not produce goose-necks unless there is an impediment in the emergence of the earhead. When the emergence is poor (peduncles shorter than the boot), the panicle being heavy and the wavy factor present, goose-necking occurs. The earhead takes a twist and dodges the boot. In such earheads, the wavy nature is easily discernible in the lower half.

Many earheads of *Bajri* (*Pennisetum typhoides*) have wavy peduncles and occasionally goose-necking occurs when there is an impediment to free emergence.

Wavy peduncled types have been true to waviness through generations. In a cross between a wavy peduncle and a straight peduncled *S. sudanense* type, the first generation plants had straight peduncles and in subsequent F_2 and F_3 generation a monohybrid segregation was obtained and confirmed.

In cultivated sorghums a cross was made between a straight peduncled type (A.S. 5157) and a wavy peduncled one (A.S. 3783). The F_1 had straight peduncles. The F_2 generation segregated and gave 163 plants with straight peduncles and 55 plants with wavy ones.

It will thus be noticed that a gene designated w_y is responsible for wavy peduncles. Gene W_y produced the common straight peduncle. Waviness occurs both in long and short peduncles. When the peduncles are shorter than the sheath, the wavy factor helps the heavy earhead to bend and this results in goose-necking. In badly emerged heavy heads without the

help of the wavy factor a part of the panicle remains stuck up within the boot with consequent unsetting in the portion enclosed.

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Millets Breeding Station,
Coimbatore,
November 11, 1941.

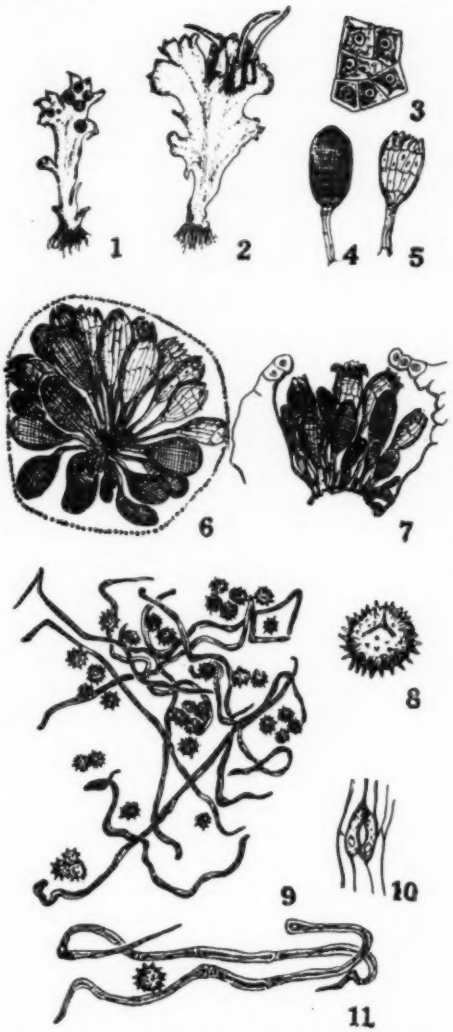
[1] *Texas Agri. Expt. Station Bull.*, 1917, No. 204.
[2] *Jour. Amer. Soc. Agron.*, 1932, **24**, 500–03.
[3] *Proc. Indian Acad. Sci.*, 1938, **7**, 286–88.
[4] *Ibid.*, 1941, **14**, 17–24.

A LONG-LOST LIVERWORT FROM SOUTH INDIA: *ASPIROMITUS*, A RARE MEMBER OF THE ANTHOCEROTES

IN July 1932, on a collecting trip to Khandala (Bombay Presidency), a form of the Anthocerotes was collected which appeared to be peculiar in many respects. The collection consisted of a large number of male thalli with peculiar antheridia but the female thalli were wanting altogether in the collection; and hence no identification of the plant was possible. A somewhat similar form[1] was also noticed to grow at Castle Rock in 1935. Year after year the plant was being collected without getting any further clues as to its identity till the year before last, when I had the privilege of working in the laboratory of Prof. Birbal Sahni at Lucknow, I handed over a few specimens of this plant to Dr. S. K. Pande who drew my attention to the fact that the antheridia in these specimens suggest it to be a species of *Aspiromitus*.[2] The definite identification of the plant, however, was not possible in the absence of any mature sporogonia.

Early in the last October and in June this year, a rigorous search for the plant was made by me at several places, and collections were made from time to time at my request by Mr. P. D. Bhate and others at Khandala from the same localities from where I used to collect the material, and subsequently at Castle Rock by Prof. D. V. Shende, and were sent to me.[3] These included female thalli with mature sporophytes and it became possible to make out the broad features in the morphology of this plant which are given below.

Description of the Plant.—Plants dicœcious, large, terrestrial, growing in close clusters, light green in colour. Fronds cavernous, more or less erect, attached to the soil by a tuft of rhizoids, smooth or tuberculate (Figs. 1 and 2). Male thalli 1–1·7 cm. long, about 6 mm. broad, erect, cuneate, furcately lobed; lobes irregular, unequal, crenulate or ligulate, with a distinct network of mucilage canals or the so-called nerves (Fig. 1). Androœcia in clusters, in two or three series, lying a little below the recurved margin of the thallus in the notches or depressions of the lobes. Antheridial cavities large, round, containing about 20–24 antheridia in each cavity (Figs. 6 and 7). Antheridia 34 μ long, 15–20 μ broad, with stalks about 24 μ long (Figs. 4 and 5), elliptical or ovate-elliptical in outline, subglobose or club-shaped (Figs. 4–7), seated on the central portion of the chamber from which they appear to radiate like the antheridia in a male conceptacle of *Fucus* (Figs. 6 and 7). Female thalli large, 2–3 cm. long, as much broad, sometimes more, subplane, growing in clusters, semi-erect, spreading in a fan-like manner, thick and fleshy, light green or yellowish green in colour, longish, furcately lobed, lobes round or ligulate, margin repand or slightly incisioned, revolute (Fig. 2). Involucres large, about 4 mm. long, fleshy, cylindrical, smooth, solitary or rarely two on a lobe, subacuminate (Fig. 2). Capsule 1·5–2 cm. long, stout, dark green, with a long foot and a columella running right up to the apex. Dehiscence of the capsule by two valves splitting it open along two vertical lines into two segments not twisting each other. Epidermal cells of the capsule elongated, and heavily cuticularised. Stomata many, about 25 μ long, 16–20 μ broad (Fig. 10). Spores dark, black when thoroughly matured, about 40 μ in diameter, echinate, mixed up with and enfolded by numerous dark, long elaters (Figs. 8 and 9). Elaters 100–160 μ long, solid, smooth, simple, septate, unbranched, pointed or blunt at ends, with inner surface cuticularised but having neither spiral nor any other kind of



FIGS. 1—11. *Aspiromitus Dixitianus* Mahabalé, n.sp. FIG. 1—Male thallus. × 1·5; FIG. 2—Female thallus. × 1; FIG. 3—A portion of the thallus showing a large single chloroplast in each cell. × 62·5; FIG. 4—Mature antheridium. × 22·5; FIG. 5—An empty antheridium. × 22·5; FIG. 6—Optical view of an antheridial cavity containing about 24 antheridia in different stages of development. × 12·5; FIG. 7—*Ibid.*, vertical section. × 12·5; FIG. 8—Spore. × 175 approx.; FIG. 9—A group of spores and elaters in the capsule. × 75; FIG. 10—Stoma on the wall of the sporogonium. × 75; FIG. 11—Two elaters magnified. × 100,

thickening, dark, deep purple or black in colour (Figs. 9 and 11).

Habitat—Moist overhanging rocks on the westward side of the ghats in the Bombay Presidency, above 2,300 feet elevation.

Locality—Hills behind the Reversing[4] Railway Station (G.I.P. Ry.), Bor Ghat, Khandala: Battery Point,[5] Khandala: Railway Bridge[6] over the Bombay-Poona Road, near Reversing Station (G.I.P.).

Systematic Position.—The plant undoubtedly belongs to the group of Anthocerotes as is evident from the fact that there is a single large chloroplast in each cell of the thallus (Fig. 3). The Anthocerotes comprise five genera: *Anthoceros, Aspiromitus, Megaceros, Dendroceros* and *Notothylas*. The stomata are absent on the walls of the sporogonia in *Megaceros, Dendroceros* and *Notothylas*, and therefore, the plant in question belongs either to the genus *Anthoceros* or to the genus *Aspiromitus*. This inference is further confirmed by the fact that the elaters in *Megaceros, Dendroceros* and *Notothylas* have spiral markings which are wanting in the elaters of *Anthoceros* and *Aspiromitus*.

The genus *Aspiromitus* differs from the genus *Anthoceros*, among other characters, in two important respects: (1) the form and number of antheridia in an antheridial cavity, and (2) the form, length, colour and thickening of the pseudo-elators. In the majority of the species of *Anthoceros* the antheridia are globose or oval, and 3–4 of them lie in an antheridial cavity, rarely 8. The antheridia of *Aspiromitus* are sub-globose, more or less club-shaped, oval-elliptical in outline and raised on long stalks. As a rule many of them are found in each cavity; or, if they are few, their size is considerably larger than that of those of *Anthoceros*. In the present plant about 20–24 of them lie in an antheridial cavity or the chamber. The other important character of the genus *Aspiromitus*, and from which it derives its name, is the nature of its elaters. They are smooth, solid, long, thread-like, usually coloured, the colour being the same as that of the spores. Unlike the elaters in the most

species of *Anthoceros* they are generally unbranched and have no spiral markings. At maturity they lie scattered in the masses of spores, especially in the upper part of the capsule; and in the earlier stages they encircle the tetrad-spores. Their length, like their colour, is quite considerable. It is 10–20 times greater than that of the elaters in the species of *Anthoceros*. For example, the length of the pseudo-elaters in *Anthoceros erectus*, with which the plant is often mixed up, is 12 μ whereas in the form under consideration it is about 100–160 μ, nearly 8–13 times greater than that of the elaters of the former plant.

From what has been said above, it is evident that the plant under consideration belongs to the genus *Aspiromitus*.

Historical.—The genus *Aspiromitus* was founded by Stephani in 1888 and is the least known member of the Anthocerotaceæ. Stephani[7] has described 53 species of this genus in his '*Species Hepaticarum*', mostly from Africa, tropical America, Java, Sumatra, and Australia. These include, *inter alia*, a species from South India named *Aspiromitus mangaloreus* St.[8] named by him after the place from where the specimens were obtained, namely from Mangalore[9] in the District of South Canara in the Madras Presidency. To the best of my knowledge this perhaps is the only record of the occurrence of this genus in India. But the plant under consideration does not seem to belong to that species, as *A. mangaloreus* St. is a monœcious form with hispidate spores, 27 μ in diameter. The present species is diœcious and has echinate spores about 40 μ in diameter. It is, therefore, not *A. mangaloreus* St.

A species novum.—It may next be enquired whether the plant under consideration belongs to any other species of this genus described by Stephani. Out of the 53 species of *Aspiromitus* described by him the following 4 species are diœcious: *A. incurvus* St., and *A. expansus* St. from Kamerun in Africa, *A. rigidus* St. from Jamaica, and *A. dioicus* St. from Amazonas in tropical America. In *A. incurvus* St. and in *A. rigidus* St. the spores are pale in colour, and in the other two species they are dark in colour. The plant in question has dark spores and it is, therefore, allied to *A. expansus* St. from Kamerun and to *A. dioicus* St. from tropical America. In *A. expansus* St., however, the spores are hispidate and about 36 μ, as against the echinate spores 40 μ in diameter in the present species. The capsules also of *A. expansus* St. are longer than those of the species under consideration: in the former plant they are 3 cm. long and in the latter they are 1·5–2 cm. long. In *A. dioicus* St. the spores are asperate and 36 μ in diameter. It also, therefore, does not seem to correspond to the form in question. But the real distinguishing feature of this species from the plant under consideration is its antheridia. The antheridia of *A. dioicus* St. are described by Stephani[10] as "*gigantea*" and 3–5 of them lie in an antheridial cavity. The antheridia of the present form are certainly not gigantic and 20–24 of them lie in each cavity. The plant under consideration, therefore, does not seem to belong to that species also. From *A. expansus* St. it differs in the size and markings of the spores and in the length of the capsules; and it differs from *A. dioicus* St. in the size and markings of the spores, and in the size and number of antheridia in each antheridial cavity. And as it does not tally with any of the species of this genus described so far, it is to be considered new. I have called it *Aspiromitus Dixitianus* sp. n. giving it a trivial specific name "*Dixitianus*" in acknowledgment of my debt to my teacher in Cryptogamic Botany, Prof. D. L. Dixit of the Fergusson College, Poona.

The type specimens are deposited in the Department of Biology, Gujarat College, Ahmedabad (Western India) and the Latin diagnosis of the species is given below.

Aspiromitus Dixitianus Mahabalé, n. sp.—*Planta* dioica, majuscula, cavernosa, erecta vel semi-erecta, terricola, flavo-virens, plus minusve cueniformis. *Frons feminina* 2–3 cm. longa, 2·5 cm. lata, dilute viridis, grosse cavernosa, robusta, subplana, longe furcata, ramis lobulata, lobis rotundis, vel ligulatis; marginibus repandis, revolutis. *Frons masculina* parva, 0·5–1·7 cm. longa, 6 mm. lata, cueniformis, irregulariter

furcata, margine inciso-lobulatis, lobis crenulatis, et ligulatis et inequilatis. *Involucra* 4 mm. longa, cylindrica, cavernosa, subacuminata, solitaria, rarius gemminata. *Capsula* 1·5–2 cm. longa, valida. *Stomata* numerosa. *Sporae* 40 μ, fuscae, generatim in statu maturo nigrae, echinatae. *Elateres* fusci, longi, simplices, septati, ejusden coloris, reticulis 4 sporas includentibus. *Andrœcia* aggregata, alveolis magnis, rotundis. *Antheridia* 34 μ longa, longis pedicellatis erecta, elliptico-ovalia, ad 20–24 in utroque alveolo.

Hab.—*India occidentalis*, Khandala, Bombay Presidency.

T. S. MAHABALE.

Department of Biology,
Gujarat College, Ahmedabad,
October 27, 1941.

[1] This form differs in some important points from the form found at Khandala and I hope to give its account in some later communication.

[2] Dr. S. K. Pande's letter to me dated 29th October 1940. I take this opportunity to thank most sincerely Dr. Pande for the brilliant suggestion, and to Dr. H. Chaudhuri, Director, Kashyap Research Laboratory, Lahore, for the loan of some books.

[3] My best thanks are due to these gentlemen and to Messrs. R. N. Deshpande, S. R. Deshpande, and Y. B. Raje for the help they rendered in getting me the proper material.

[4] Mr. R. N. Deshpande's collection, 1932.

[5] The author's collection, 1932.

[6] Coll. P. D. Bhate, 1940; Y. B. Raje, 1932, 1941; S. R. Deshpande, 1941.

[7] Stephani, F., *Species Hepaticarum:* Acrogynæ, 1916, **5**, 957–71.

[8] —, *op. cit.*, p. 967.

[9] In giving the habitat of this species, Stephani (*loc. cit.*, p. 967) says: "*India orientalis*. Mangalore". Obviously he is mistaken in the former part of his statement. Mangalore is on the west coast of India.

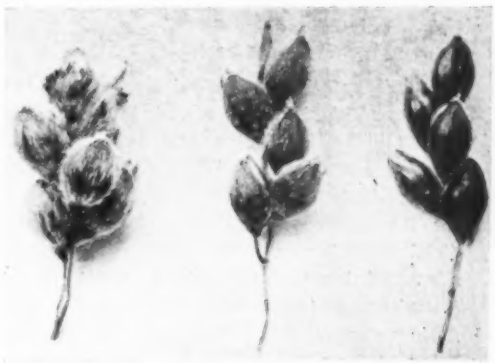
[10] Stephani, *loc. cit.*, p. 964.

SORGHUMS WITH FELTY GLUMES

THE distribution and inheritance of hairs in certain parts of the sorghum plant have been recorded in two previous papers.[1,2] Both the glumes can be hairy or 'glabrous'. When hairy the lemmas and the palea are also hairy. All glumes are hairy in some degree or other. The 'glabrous' glumes present a shiny surface with odd hairs and are fringed sparsely with hairs at the periphery. This sparseness is extreme when the glumes are tough and leathery. The hairy condition has been recorded as a monogenic dominant to the 'glabrous' (sparsely fringe hairy) condition.[3]

In cultivated sorghums the hairs are adpressed to the glume and are from 0·5 to 0·7 mm. in length. Against a background of shiny glumes of the type furnished by *Sorghum dochna*, these hairs glisten in the sun. There is a general tendency for the nodal band to be hairy when the glumes are hairy, but there are exceptions to this simultaneous manifestation. In wild sorghums the hairs are finer than in cultivated sorghums; in *S. sudanense* and *S. virgatum* the length is 0·3 to 0·4 mm. and in other varieties it is 0·5 to 0·6 mm.

A rare type of hairiness in which the hairs are longer (1·2 to 1·5 mm.) and give the glume a *felty* appearance has been met with in a cultivated variety from Tinnevelly, South India, belonging to the group *S. dochna* var. *burmanicum* (Photograph). Similar types of felty glumes are found to occur in some types belonging to *S. Roxburghii*, *S. caffrorum*,



Felty Glume | Hairy Glume | 'Glabrous' Glume

S. coriaceum and *S. cernuum*. When the glume is felty (long hairs) the hair length increases

in the panicle parts that could be hairy. Though the glume hairs are long, the hairiness on the nodal band retains the usual length (0·1 mm). After the milky stage the hairs begin to drop off.

The relationship of the felty glume to the ordinary hairy glume was pursued in a cross between the felty *S. dochna* var. *burmanicum* and another *S. dochna* which was merely hairy. The F_1 was felty and in the F_2 two segregating families gave a total of 156 felty to 51 hairy glumes.

A second cross was made between the felty glume and another *S. dochna* which was 'glabrous' (short hairs at the fringe). The F_1 was felty and in the F_2 two segregating families gave the following figures: 160 felty, 47 hairy, 49 'glabrous' (long hairs at fringes) and 17 'glabrous' (short hairs at fringes), a clear dihybrid ratio. An F_3 of 16 families was raised and they behaved as follows: One selection, fringes short hairy: pure. Three selections, fringes long hairy: two pure and one segregated giving 90 long and 33 short hairs at the fringes. Three selections hairy: two pure and one segregated giving 42 hairy and 15 fringes short hairy. Nine selections of felty glumes: three pure, two segregated giving a total of 164 felty and 55 hairy, two segregated giving a total of 186 felty and 58 fringes long hairy, two repeated the dihybrid ratio, the numbers being 131; 39; 38 and 11.

In wild sorghums the hairs are finer and smaller. This is to be expected as they are not as big and robust as the cultivated sorghums. Even in the wild sorghum there are long and short hairs. The gene responsible for the sparse manifestation of glume hairs ('glabrous') is rare in the wild sorghums. In a cross between *S. Stapfii* (long hairs) and *S. sudanense* (short hairs) a similar monogenic segregation was obtained, the numbers being 81 long and 29 short hairs.

From the above data it will be noticed that a dominant gene designated Gh is responsible for the hairy condition of the glume. Gene gh results in a virtually 'glabrous' glume, the fringes being hairy with stray hairs on the body of the glume. Another gene Gf accentuates the length of the hairs to a felty condition and is a monogenic dominant to gf giving the common hairy condition. Genes Gh and Gf act independently in inheritance.

G. N. Rangaswami Ayyangar.
B. W. X. Ponnaiya.

Millets Breeding Station,
Coimbatore,
November 17, 1941.

[1] *Curr. Sci.*, 1939, **8**, 115–16.
[2] *Madras Agri. J.*, 1939, **27**, 210–14.
[3] *Jour. Madras Agri. Students' Union*, 1924, **12**, 1–17.

DEVELOPMENT OF GLANDULAR HAIRS IN *ORTHOSIPHON STAMINEUS* BENTH.

The plants belonging to the Family Labiatæ have long been famous for the various essential oils extracted from many of them for the manufacture of perfumes and medicinal preparations. The volatile oils, which impart to the plants their characteristic aroma, are secreted by different types of glands present on the several parts of the plant. The structure and development of these glands and a detailed study of their cytoplasmic inclusions are being investigated by the author.

In *Orthosiphon stamineus* numerous multicellular glandular hairs are present on the calyx, corolla, anthers, and around the base of the gynobasic style. Non-glandular hairs also occur along with them especially on the calyx and the tubular corolla. A well-developed glandular hair consists of a stalk composed of two to three cells and a shield-shaped head portion of eight cells which constitute the gland proper. The development of a glandular hair commences with the protrusion of an epidermal cell from the rest of its accompanying cells (Fig. 1). This cell divides by a periclinal wall into a glandular head-cell and a stalk-cell (Fig. 2). The stalk-cell divides again periclinally into a middle cell and a basal cell. The

head-cell divides anticlinally into two cells (Fig. 3). These cells divide further into four (Figs. 4 and 5), and then into eight cells (Fig. 6). The middle stalk-cell gradually bulges into the base of the glandular head-cells. The volatile oil is secreted beneath the cuticle, which becomes raised like a bladder over the gland cells, owing to the accumulation of secretion (Figs. 3, 4 and 6). The basal stalk-cell often divides into two cells by a radial wall (Fig. 4). The glandular hair is thus differentiated into a secreting region and a storage region. The volatile oil escapes into the atmosphere when the distended cuticle bursts under the pressure of its contents thus producing the characteristic aroma.

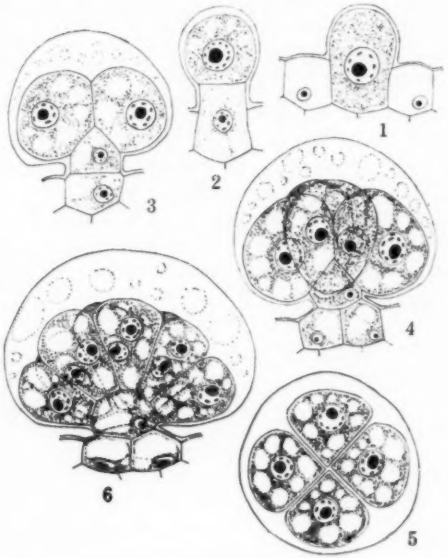


FIG. 1—Protruding epidermal cell. × 100.

FIG. 2—Division of the epidermal cell into a stalk-cell and a head-cell. × 100.

FIG. 3—Division of the head-cell into two cells. ×100.

FIG. 4—4-celled stage of the glandular hair. × 100.

FIG. 5—Transverse section of a glandular hair at the 4 celled stage. × 100.

FIG. 6—8-celled glandular hair. × 100.

In conclusion the author feels indebted to Dr. M. A. Sampathkumaran, Professor of Botany, University of Mysore, for his kind criticism of the paper.

S. NARASIMHA MURTHY.

Department of Botany,
Central College, Bangalore,
October 29, 1941.

TADPOLES AS HOSTS FOR THE GLOCHIDIA OF THE FRESH-WATER MUSSEL

IT is well known that an obligatory period of parasitism on a suitable fish host is an important phase in the life-history of the fresh-water mussel. But are fish the only suitable hosts for the Glochidia to metamorphose into juvenile mussels? All accounts which we have, so far, on the development of the Unionidæ speak of the metamorphosis of the Glochidium encysted in the tissues of fish hosts only. Faussek,[1] Arey[2] and Herbers[3] utilised aquatic vertebrate hosts other than fish for studying the attachment of the Glochidia and their subsequent encystation in the tissue of the host, but there is no mention of the metamorphosis of the Glochidia in their experiments. On the other hand, Arey[2] definitely mentions that 'the larvæ of the fresh-water mussel cannot metamorphose without passing a semi-parasitic period buried in the superficial tissues of appropriate *fish hosts*' (Italics mine). Herbers utilised the tadpoles of *Rana* and *Pelobates*, but found that the Glochidia dropped off after some time without metamorphosis.

Attachment of the Glochidium to a host and subsequent formation of a cyst in the tissues of the host do not necessarily indicate that the host is an appropriate one and that the encysted parasite will metamorphose into the juvenile mussel. Glochidia may be made to infect species of fish and other aquatic vertebrate hosts which possess a natural immunity. In such cases the Glochidia drop off without metamorphosis. I find that the Glochidia can be made to attach themselves even to invertebrate aquatic hosts like the Glossiphonid leeches.

Recently, in the course of my studies of the Unionidæ, I infected the tadpoles of *Rhachophorus* and *Rana* with the Glochidia of *Lamellidens* and observed the metamorphosis of the encysted Glochidia into juvenile mussels. In the first series of my experiments I used very young tadpoles of *Rhachophorus* and later stages of those of *Rana*. The Glochidia encysted in the tissues of *Rana* failed to metamorphose, while those in *Rhachophorus* metamorphosed into normal juvenile mussels.

With a view to finding out whether this failure of the Glochidia to metamorphose was due to the harmful effect of the chemical substance which is said to be produced in the degenerating tail of the metamorphosing tadpole, or whether it was due to the dense pigment in the integument of the tadpoles of *Rana*, or to any specific natural immunity of the tadpoles, a second series of experiments were carried out with proper controls. In these experiments the tadpoles of *Rana* were infected in the different regions of the body including the thigh and the web of the hind limb. Tadpoles which had been kept in the laboratory for some length of time and had lost much of their pigment, as well as species of tadpoles which are normally with little or no pigment, were infected with Glochidia. The experiments showed conclusively that the dense pigment of the integument prevents the metamorphosis of the encysted larvæ, and kills them. Glochidia encysted on the thigh, web and other regions of the body with little pigment, as well as those encysted in the tissues of the pigmentless species, metamorphosed normally. In one instance I could actually observe the metamorphosing larva struggling slowly out of the cyst on the thigh and dropping out as the juvenile mussel.

In the case of the larvæ encysted in the densely pigmented regions of the body, examination of sections showed that the development proceeds to a fairly advanced stage, but later on, the mantle cavity of the larva is invaded by the pigment and becomes gorged with it, resulting in the arrest of the metamorphosis and subsequent shedding of the cyst. I have not yet determined whether the death of the larva is due to the chemical nature of the pigment or to its choking effect.

Other interesting features were also observed in the course of the work, particularly the very rapid repair of the wound after the dropping of the metamorphosed Glochidium, the movement of the surrounding tissue into position, to fill up the breach caused by the rupture of the cyst, being clearly perceptible under the microscope.

Further work is in progress.

R. V. Seshaiya.

Annamalai University,
November 10, 1941.

[1] Faussek, V., *Biol. Centralbl.*, 1895, **15**; *Zool.-Kongr.*, Berlin, 1901.

[2] Arey, L. B., *Biol. Bull.*, 1932, **62**; *Jour. Morph.*, 1932, **53.**

[3] Herbers, K., *Z. f. wiss. Zool.*, 1913, **108.**

KTENOSTREPTUS SPECULARIS ATTEMS 1936—A CEYLONESE MILLIPEDE

Recently in looking up the literature on Indian Diplopoda I have come across a reference to *Ktenostreptus specularis* by Attems (1936) who says, "*Ktenostreptus specularis* has been found in Ceylon and in India (Lucknow)."

This millipede has never been found in Lucknow. The body of this millipede is jet black in colour, its antennæ and legs are yellow, and its size is about 1½ times larger than the biggest Lucknow millipede. In December 1930 I sent a collection of millipedes from several parts of India including a few specimens of *Ktenostreptus specularis* (which are obtained by me from Ceylon for purposes of comparison with the local forms) to Dr. Attems at Vienna. It appears some of these specimens got mixed up at the Naturhist. Museum, Vienna, and hence the error in Attems' work published in 1936.

There is, however, one point which needs further consideration. In describing *Ktenostreptus specularis*, Attems mentions that the

Lucknow specimen (male) has 54 segments and the Ceylon specimen (female) has 65 segments and the length of the millipedes is 16–19 cm. My own observations on these millipedes reveal that the length and the number of segments varies with individuals as follows:—

Female:				
Specimen	A	18·5 cm.	67	segments including Collum & Anal ring.
,,	B	18·7 cm.	67	,, ,,
,,	C	19·1 cm.	67	,, ,,
Male:				
,,	D	19·0 cm.	67	,, ,,
,,	E	19·3 cm.	68	,, ,,
,,	F	20·3 cm.	68	,, ,,

The present communication will also emphasize further the endemism of Indian Diplopoda which has been referred to by Attems (1936) who says, "only 6 or 7 species are common to two parts—Peninsula and Ceylon".

M. B. LAL.

Lucknow University,
November 24, 1941.

RAMANUJAN: HIS LIFE AND WORK

IN his review of G. H. Hardy's book on 'Ramanujan: His Life and Work', appearing in the July (1941) number of *Current Science*, Prof. Siddiqi says: "There is one remark of Prof. Hardy with which it is difficult to agree. Prof. Hardy says, 'I very much doubt whether Ramanujan, to the end of his life, ever understood at all clearly what an analytic function is'. It should be remembered that Ramanujan stayed at Cambridge for more than three years and *passed the Mathematical Tripos*. ..... However, if Prof. Hardy's conjecture is true, it does not speak much for the teaching of Mathematics at Cambridge which could not make a Ramanujan understand the nature of an analytic function at the end of a three years' course. We hardly think that Prof. Hardy himself would like to be forced to this conclusion".

It is incorrect to say that Ramanujan took the Mathematical Tripos, for, the B.A. Degree that he obtained at Cambridge was only a research degree. A life-sketch in the *Journal of the Indian Mathematical Society*, August 1919, says, "At Cambridge he was given the research degree and the frontispiece shows him in his academical robes."

Prof. Hardy himself observes in the collected papers of Ramanujan: "He wished indeed to qualify for a Cambridge degree as a research student but this was a formality".

K. CHANDRASEKHARAN.

Department of Mathematics,
University of Madras,
October 7, 1941.

I ACKNOWLEDGE my mistake, and gratefully accept Mr. Chandrasekharan's correction. However, I plead that my mistake was natural for various reasons.

(1) Before the last Great War, Cambridge academic life was dominated by the Mathematical Tripos, and every promising mathematics student went there for the Tripos. I was therefore under the impression that Ramanujan's Cambridge B.A. must have been due to his having taken the Tripos.

(2) The lowest research degree at Cambridge or any other University is that of M.Sc., and it would come as a surprise to most people that Ramanujan was awarded a research B.A. Degree at Cambridge.

I am not disputing the fact, but only explaining why the details about Ramanujan's degree escaped my notice. Both the quotations given by Mr. Chandrasekharan do not specify the 'B.A. Degree', but mention only the research degree. I assume with Mr. Chandrasekharan that they refer to the B.A. Degree. Anyway, one does not think much of degrees in connection with Ramanujan. They are immaterial. The main point for the purpose of my argument is, as I have explicitly stated in the passage cited by Mr. Chandrasekharan, that Ramanujan stayed at Cambridge for more than three years. During this time he must have met and talked with many mathematicians at Cambridge—not to speak of Prof. Hardy himself, whom he met almost every day.

RAZIUDDIN SIDDIQI.

Osmania University,
Hyderabad (Deccan),
November 17, 1941.

A NOTE ON THE LATE MR. DEV DEV MUKERJI'S MANUSCRIPT DRAWINGS OF THE AIR-BLADDER OF THE GOBIOID FISHES OF THE GANGETIC DELTA[1]

By SUNDER LAL HORA

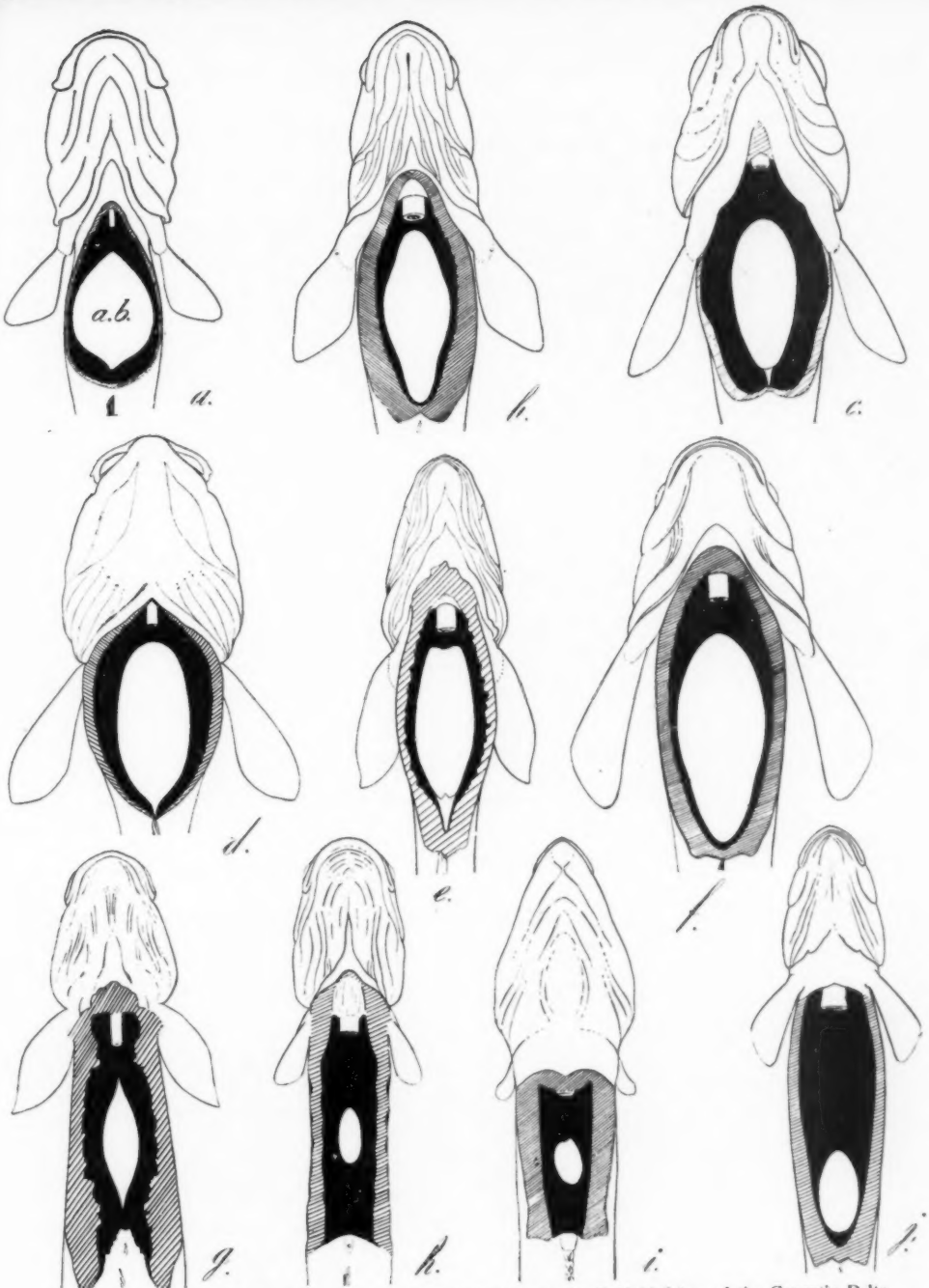
(Zoological Survey of India, Calcutta)

IN my[2] note on the modification of swim-bladder in certain air-breathing fishes of India, among other things, attention was directed very briefly to the correlation between the form and position of the bladder and the mode of life of the Gobioid fishes of the Gangetic Delta. In a foot-note it was stated that "Mr. Dev Dev Mukerji of the Zoological Survey of India is at present engaged in investigating the correlation between the structure of the air-bladder and the ecological factors in the case of Gobioid fishes in the Gangetic Delta". Mr. Mukerji had drawings made of the dissections of various species showing the position and extent of the air-bladder in each case, but before he could write his article the cruel hand of Death snatched him away in the prime of his life.[3] Recently Rahimullah[4] described the gas-bladder of the Gobioid fish, *Boleophthalmus boddarti* (Pallas), a common species of the Gangetic Delta, and it occurred to me that the publication of the late Mr. Mukerji's manuscript drawings with such comments as I am in a position to offer, may be of some use in the elucidation of the correlation referred to above and hinted at by Rahimullah also.

An ecological zonation of the Gobioid fishes[5] of the Gangetic Delta and an account of their bionomics has already been published,[6] but it may be worthwhile to reiterate here that of all the Gobioid species found in this habitat *Glossogobius giuris* (Ham.), *Gobiopterus chuno* (Ham.) and *Brachygobius nunus* (Ham.) are the most aquatic forms, though even they are capable of living out of water for shorter or longer periods depending upon meteorological conditions. *Eleotris fusca* (Bl. and Schn.) and *Butis butis* (Ham.) are usually found near the edges of ponds and other collections of water in thick vegetation, but are more or less aquatic in their mode of life. They are, however, more tenacious of life than either *Glossogobius, Gobiopterus* or *Brachygobius*. *Apocryptes bato* (Ham.), which is found in burrows on muddy banks near lowtide mark and in outlying shallow portions of the tidal pools, etc., and *Stigmatogobius sadanundio* (Ham.), which is found in crab holes along the banks of pools and narrow channels, live under water for most of their time, though they may sometimes be exposed to aerial conditions at low-tide. *Odontamblyopus rubicundus* (Ham.) and presumably *Trypauchen vagina* (Bl. and Schn.)[7] also live in deep burrows along the sides of streams near low-tide mark and in tidal pools which may dry up occasionally for a short period. *Pseudapocryptes lanceolatus* (Bl. and Schn.) lives in deep burrows in spring-tide pools, which dry up for days together in between the high tides. *Boleophthalmus boddarti* (Pallas) is found on muddy banks between tide marks, but the almost terrestrial form extensively met with in the Gangetic Delta is the mud-skipper, *Periophthalmodon schlosseri* (Pallas).

Correlated with the differences in the respective mode of life of the various species as indicated above, it is interesting to note that the physoclist air-bladder of *Glossogobius, Gobiopterus* and *Brachygobius* is fairly extensive and occupies a considerable part of the body cavity. The air-bladder of *Glossogobius giuris*, which lives in comparatively deeper and more permanent pieces of water, is relatively much larger. In shore forms, such as *Eleotris fusca* and *Butis butis* and *Stigmatogobius*, which lives in shallow and relatively broad holes, the air-bladder is still extensive, but in *Apocryptes bato*, which lives in burrows under water or near low-tide mark, the bladder has become spindle-shaped and considerably smaller. In *Odontamblyopus* and *Trypauchen*, both of which live in deep burrows, the bladder is greatly reduced, but is still situated in the middle of the abdominal cavity, a stage of reduction already indicated in the spindle-shaped bladder of *Apocryptes bato* (Ham.), while in *Pseudapocryptes*, which is more subject to desiccation than the species mentioned above, the reduced bladder is situated in the posterior part of the body cavity. I (1935,

[1] Published with the permission of the Director, Zoological Survey of India.



The late Mr. D. D. Mukerji's drawings of the air-bladder of the Gobioid fishes of the Gangetic Delta.

a—*Glossogobius giuris* (Ham); b—*Gobiopterus chuno* (Ham.); c—*Brachygobius nunus* (Ham.); d—*Eleotor fusca* (Bl. & Schn.); e—*Butis butis* (Ham.); f—*Stigmatogobius sadanundio* (Ham.); g—*Apocryptes bati* (Ham.). h—*Odontamblyopus rubicundus* (Ham.); i—*Trypauchen vagina* (Bl. & Schn.); j—*Pseudapocryptes lanceolatus* (Bl. & Schn.).

p. 336) did not find any air-bladder in *Boleophthalmus* and *Periophthalmodon*, but Rahimullah (*loc. cit.*) has described and figured a small, ovoid or ellipsoidal bladder in *Boleophthalmus* lying freely in the body cavity. There seems to be some mistake in Rahimullah's account where he correlates the presence or absence of the air-bladder in *Boleophthalmus* and *Periophthalmus* with their respective mode of life and states that "though the habits and habitats of *Boleophthalmus boddarti* (Pallas) are more or less similar to those of *Periophthalmus*, a small gas-bladder in *Boleophthalmus* is associated with its more pronounced terrestrial mode of life. As is well known and as has been stated above, the mode of life of *Periophthalmus* and *Periophthalmodon* is much more terrestrial than that of *Boleophthalmus* and this is further borne out by the fact that the air-bladder is completely absent in the two terrestrial genera of the Gangetic mud-skippers.

A comparison of the late Mr. Mukerji's figures with the ecological conditions under which the respective species live makes it abundantly clear that the reduction and finally the absence of air-bladder in the Gobioid fishes of the Gangetic Delta are definitely correlated with the progressively terrestrial habit of the species. Attention may here be directed to the fact that in the fishes of the hill streams[8] a similar reduction of air-bladder is induced by the pronounced ground-habit life of these fishes. Thus one is led to the conclusion that adaptation to the requirements of some important factor in a habitat is the main inducement for the structural modifications undergone by allied organisms living under diverse or apparently similar conditions.[9]

[2] Hora, S. L., *Curr. Sci.*, 1935, **3**, 336.
[3] —, "Obituary, Mr. Dev Dev Mukerji (1903–37)," *Ibid.* 1937, **5**, 439.
[4] Rahimullah, M., *Ibid.*, 1941, **10**, 440.
[5] The nomenclature used here is after Dr. F. P. Koumans "Gobioid Fishes of India," *Mem. Ind. Mus.*, 1941, **13**, 203.
[6] Hora, S. L., *Comptes Rendus du XII Cong. Internat. Zool.*, pp. 841–63 (Lisbon, 1935).
[7] Though *Trypauchen vagina* is found in the estuaries of the Ganges, neither the late Mr. Mukerji nor I had any occasion to make observations on the living specimens.
[8] Hora, S. L., *J. Bombay Nat. Hist. Soc.*, 1930, **34**, 374.
[9] —, *Phil. Trans. Roy. Soc. London*, (B), 1930, **218**, 171.

RESPIRATORY ENZYMES AND THE BIOLOGICAL ACTION OF THE VITAMINS—A SYMPOSIUM

Report of the Proceedings

BY FRITZ SCHLENK

(*University of Texas, U.S.A.*)

A SYMPOSIUM dealing with the problems on Respiratory Enzymes and the Biological Action of Vitamins, was conducted jointly by the University of Wisconsin and the University of Chicago, from September 11–17, in which many outstanding men in the field took part. The enzymes were discussed mainly in the Madison section, the vitamins, subsequently at Chicago. The participants were accommodated in the splendid dormitories of the Universities, an arrangement which provided opportunities not only for establishing personal contacts but also for holding intimate discussions on subjects of mutual interest.

The programme included 28 papers on various aspects of the subject and open discussions on (1) Phosphorylation, (2) Hydrogen transport, (3) Tumor respiration, (4) Bacterial respiration and (5) Animal tissue respiration.

The most outstanding events were the lectures given by O. Meyerhof, T. R. Hogness, C. F. Cori, C. A. Elvehjem, T. D. Spies, R. J. Williams and V. duVigneaud.

The splendid introductory talks of O. Meyerhof at Madison and C. A. Elvehjem at Chicago were general reviews on carbohydrate metabolism and on the biological action of the vitamins, respectively.

The lectures given in Madison will be published very soon by the University of Wisconsin Press, and there is every hope that the Chicago lectures will also be published.

The Symposium was supported by funds from both the Wisconsin Alumni Research Foundation and the Abbott Laboratories. The sessions at Chicago formed a part of the University of Chicago's semicentennial celebration.

REVIEWS

The Identification of Molecular Spectra. By R. W. B. Pearse and A. G. Gaydon. (Chapman and Hall, London), 1941. Pp. viii + 221. Price 42*sh.* net.

Anyone who has worked with vacuum tubes knows how persistent are the unwelcome bands from unsuspected impurities lurking after even the most careful purification, the CO and CN bands being the most frequent. Their presence is annoying enough when they hide important atomic lines but when one is trying to locate the bands due to a molecule whose spectrum has not been previously studied thoroughly, they may lead the unwary investigator into Pickwickian discoveries. It is, therefore, a very necessary aid to have a handy list of all known band systems. Apart from this negative kind of service which such a list can render there are positive uses also. If an unknown system appears with a known system we have an important clue to its origin. Also, whereas now we are able spectroscopically to analyse any specimen as to the elements it contains by means of its atomic spectrum, we may expect in the near future to find a similar role played by band spectra in the analysis of compounds, particularly so as regards the electronegative constituents. Although a table of band systems is thus a pressing need, we have not so far had a serviceable list except for the information to be found in such books as Jevons's *Report on Band Spectra* and the *Tabelles Annuaires*. The present writer had made a list of the most frequently occurring systems for his own use from the above sources, but the list was not extensive and additions were being made only when some system occurring on his plates proved intriguing and was at last identified. In the case of atomic lines we have excellent tables, but the field of band spectra was so far not provided with similar guides. This defect has been remedied with conspicuous success by the tables now under review. The problem of facilitating ready reference without making the list so extensive as to favour chance coincidences, thus defeating its very purpose, has been admirably solved by giving two lists—one in order of wavelengths for the most important heads of all the systems dealt with and another in order of the chemical symbols of the molecules wherein most of the known systems are collected under the corresponding compounds. The most intense head of a system to be identified is looked for in the first list according to its wavelength and knowing the probable emitter from this, its whole spectrum is then found from the second part and if all the bands to be expected under the conditions of the experiment are found, the emitting molecule can be identified with certainty. The authors have further enhanced the value of a mere list of wavelengths—by the way, this list itself is an advance in that wave-lengths of heads are consistently given to 0·1 A—by giving information about the intensity, appearance and conditions of occurrence. On examining the list, we have found only one thing to regret, *viz.*, that in many cases only the (0, 0) band is listed so that if by reason of the region included in a plate this particular head is not present, identification becomes difficult. In a very few cases the band origin has been given instead of the head, but it is only in one or two instances that we have found the origin listed but wrongly quoted as a head. It is not also possible from these tables alone or from the references included in them, to find whether a head suspected to be a new member of a known system has been previously observed or not. No information is also to be found regarding the formula representing a system or the heat of dissociation of any state. Of course these are not necessary for identification but would be useful in other ways and it is always pleasant to be able to find some required information without too much search amidst the literature and without too much trouble in collecting references. If we can therefore venture on a suggestion to increase the value of the work, it will be to recommend that the (0, 1), (1, 0), etc. heads may also be entered, particularly if they are rather distant from the (0, 0) band. Formulæ and heats of dissociation would also be welcome as also information regarding the rotational analysis where it exists. The plates given at the end of the book are a very valuable feature while the hints regarding sources and

other experimental details are quite welcome, particularly so since they embody the results of extensive research experience. Apart from a feeling that the price is rather heavy for a poor country like India, we have nothing but praise and welcome for these extremely useful tables. T. S. S.

Electrodynamics. By Leigh Page and Norman Ilsley Adams (Jr.). (Chapman & Hall, London), 1941. Pp. xii + 506. Price 32*sh.*

This book is designed as an advanced text on the theoretical aspects of electrodynamics, treated consistently from the relativistic standpoint. It may be said at once that the book is a valuable addition to the existing number of text-books on the subject. The exposition is throughout on a uniformly high level of precision and clarity, and there are plenty of little bits—"einzelheiten"—which catch the eye even at a casual glance. The treatment of the subject proper is prefaced by two chapters dealing with vector analysis and special relativity respectively. In the first chapter three-dimensional vector analysis is treated at some length, modelled after the exposition by Gibbs, while four-dimensional vector analysis is postponed to the penultimate chapter. The treatment of special relativity in the second chapter is a slight modification of the method adopted by Milne in his development of kinematical relativity. It may be doubted whether it is advisable to compel the student to base his study of electrodynamics on a mode of development of relativity the implications of which have not yet become fully clear and which has not yet received the unqualified approval of physicists in general. The fundamental equations of the electromagnetic field are derived from an emission theory which ascribes physical reality to the lines of force and regards each line of force as 'a dense linear aggregate of moving elements' emitted by an element of charge. The authors give it as their opinion that this is the only logical mode of development of electrodynamics. One feels that this is perhaps a matter of opinion only and that, after all, there is something to be said for the phenomenological method, particularly from the pedagogic standpoint. Further the emission theory developed by the authors introduces a new entity into the field—the moving elements, whose physical nature remains obscure. These and other features, together with the method of development of special relativity make the initial development of electrodynamics as presented in the book appear somewhat formidable, though perhaps this may really be so because of a smaller number of initial hypotheses made.

When the fundamental equations have once been established the development proceeds smoothly, and a variety of topics is covered including the classical theory of the spinning electron, the motion of ions in uniform electric and magnetic fields with applications to metallic conduction, waves guided by perfect and imperfect conductors, and the axially symmetric radiation fields due to the oscillations of spherical and spheroidal conductors. The account of the application of general dynamical methods in the last chapter is quite good and includes applications to the motion of a point charge in a static electromagnetic field and to the theory of cosmic ray trajectories.

We have no doubt the book will be very useful to all serious students of electrodynamics as well as to all who are interested in the study or teaching of mathematical physics. V. R. T.

Differential Equations. By G. S. Diwan and D. S. Agashe, Bombay, 1941. Pp. ix + 316.

Advanced mathematical text-books by Indian authors are somewhat rare and we have had to depend for the most part on English, American and other foreign books. We have, therefore, no hesitation in offering a warm welcome to the present text on differential equations by Messrs. Diwan and Agashe. It covers, somewhat rigidly, the traditional syllabus in the subject as prescribed in most of our Universities. Within the restricted limits which the authors have set themselves, they have taken pains to provide full explanations and also large collections of representative examples for practice. The printing and general get-up of the book are quite good and compare favourably with those of the best foreign publications.

It is to be regretted that the authors have followed too closely in the time-honoured tradition of the older English text-books, which place an undue emphasis on the formal side of the subject, to the detriment of the more fundamental and practical aspects. Thus in treating the particular

integral of a linear differential equation with constant coefficients, the authors reproduce the customary elaborate set of rules pertaining to several hypothetical cases, while in practice the method is effective in only two cases, *viz.*, when the right-hand side is of the form x^n *or* $x^n e^{ax}$. One would prefer, for example, the simple and unitary treatment in de la Vallee Poussin's *Cours d'Analyse*, especially as the time and labour spent in learning the various formal manipulations involving inverse operators is scarcely commensurate with the resulting gain. No mention is made of existence theorems, graphical and numerical methods of integration or integration in series. As the latter methods are of main importance in the applications to many problems in analysis as well as to problems in mathematical physics and engineering and as the discussion of the existence of a solution is an indispensable preliminary to the application of such methods, the complete omission of these topics is somewhat surprising.

Some remarks of a general nature may not perhaps be out of place here. Given a differential equation the questions that arise are (1) whether a solution exists and whether it is uniquely determined by the given conditions, (2) whether the solution can be expressed in terms of known functions, and if it is not, the nature of the function defined by the differential equation, and (3) whether we can approximate to the solution to a degree sufficient for the needs of practical problems. A reasonably liberal course on differential equations must touch, however lightly, on all these points, but it must be admitted that few of the existing texts meet these requirements. It may be urged, and with justice, that text-books are written in conformity with the demands of the official curricula in the subject and cannot afford to deviate therefrom. True, text-books when written are guided by the syllabus, and syllabuses when framed are fashioned on the existing texts and so the pernicious circle perpetuates itself! The dead-hand of an ancient and fossilised syllabus still oppresses us and we are still content with teaching our boys nothing more than a set of rules for solving a few types of artificially constructed differential equations which bear little resemblance to those which naturally present themselves either in pure mathematics or in mathematical physics and engineering. It is high time that the present curricula were transformed into something more liberal, more educative and more useful. One might perhaps then look forward to the appearance of texts which possess something of the freshness and flavour of the expositions by Bieberbach, Courant-Hilbert or Horn. V.R.T.

The Scientific Photographer. By A. S. C. Lawrence. (Cambridge University Press), 1941. Pp. x + 180. Price 18*sh*.

The book attempts to give a short account of the possibilities and limitations of photography, according to the author's ideas, primarily for the scientific worker, but also for the serious amateur who has an elementary knowledge of Chemistry and Physics.

Although photography has been employed in a number of different ways in the past few years, for instance in detecting new radiations and in fixing tracks, there does not appear to be adequate use made of photography in scientific laboratories. It appears that there is also no organized attempt yet made for using the cinematography either for research or for serious teaching.

The main purpose of this work seems to be to help workers in science laboratories. The usual descriptions of the numerous appliances and operations are given as briefly as possible, laying considerable stress on such items as are bound to be of much value in scientific photography, like lighting, angles, depth, etc. Most of them are discussed in an interesting manner and with an eye on usefulness.

Some scientific applications of the cine-camera are mentioned. A suggestion is made that the time is rapidly approaching when a film service will be an integral part of every big library, especially of those attached to technical establishments, so that anyone requiring information will be supplied with film copies of anything that is required. With the increasing cost of equipment of a varied nature in the laboratories, it is suggested that numerous demonstrations, too complicated to be carried out at lectures, should be filmed and shown at every university in the world every year. This is a very vital suggestion and presumably very economical but not until the authorities concerned are able to realize the power of the film for education.

The portions dealing with the correction of defects like under-exposure, over-develop-

ment, etc., are particularly interesting. A special section is devoted to record photography. There is on the first line of page 143 a mistake, obviously due to oversight. The figures and pages referred to should be 50 (*a*) and (*b*) and 87, 89. The last chapter on some scientific applications of photography and the Bibliography supplied at the commencement of the book enhance its value.

G. R. P.

The Ecology and Control of the Forest Insects of India and the Neighbouring Countries. By C. F. C. Beeson. (Forest Research Institute, Dehra Dun), 1941. Pp. ii + 1007. Price Rs. 14.

In planning this book, the author, as he states, in his Preface, was greatly helped by the official opinions of forest departments and many individual suggestions. It must be said at once, that the author, on his part, has seen to it, that the book meets admirably the needs, not only of the divisional officers and his staff and the lecturers in forest colleges, but also of research workers and entomologists in general.

The section dealing with the history of Forest Entomology in the Indian Region, makes very interesting reading; it only confirms as in the case of Agricultural and Veterinary and Medical Entomology that the progress in the development of Entomological research in India, though slow, has been steady and on correct lines and that a sound foundation has been laid for further progress, for which there is wide scope as well as need.

This book of 1007 pages is divided into two principal parts: (i) The Ecology of Forest Insects, and (ii) The Control of Forest Insects. In Part I (pages 19 to 792) a detailed and scientific classification of insects is dealt with, in addition to presenting fairly exhaustive accounts of the life-histories, habits, natural enemies, economic importance and other associated factors. The families of beetles, such as Cerambycidæ, Curculionidæ and Scolytidæ, which include most of the common species of wood borers, naturally occupy the greater portion of the group Coleoptera. The orders Diptera and Hymenoptera, including a large number of very important natural parasites of harmful insects, are very well represented; even mosquitoes under Diptera and honey bees under Hymenoptera, are dealt with, to the extent they interest forest officers. The order Isoptera, comprising many injurious species of termites or white ants, whose activities are well known, claims some 30 pages. Lepidoptera, the group of butterflies and moths, stands equal in importance to Coleoptera, in forest entomology and has, naturally, been handled exhaustively by the author. Information about the most common of the bugs (Rhychota) affecting forest trees, specially in the nurseries, will be found extremely handy and up-to-date by the divisional officers stationed far away from head-quarters.

In Part II, the all-important factor of insect control has been dealt with under two simple and clear heads, namely natural control and artificial control. The work of natural control, largely influenced by meteorological factors like temperature, rainfall, humidity, wind, sunshine, etc., that are beyond human power, and others like food in quantity and quality and finally by such of those plant and animal organisms living a parasitic life, has been described in a very lucid manner. Under artificial control, the author has adopted the conventional method of classification and has touched on most of the latest developments in the use of contact poisons, repellents, stomach poisons, fumigants and preservatives. Forest officers, no doubt, have to specially thank the author for the very useful tips given to them in the control of some of the most important and common injurious insects. Biological control of harmful insects and noxious weeds has not been forgotten and forms an interesting and instructive sub-section.

The volume has been very neatly got up; the numerous line drawings and photographs, descriptive charts and graphs together form an additional attraction to the reader.

Synoptic Tables for the Identification of the Full-Grown Larvae of the Indian Anopheline Mosquitoes. By I. M. Puri. Health Bulletin No. 16, Malaria Bureau, No. 7. (Manager of Publications, Government of India, Delhi), 1941. Price As. 14 or 1*sh.* 3*d.*

The main section of this bulletin, as the title indicates, consists of identification keys for full-grown *Anopheles* larvæ occurring in India. None is better qualified to draw up such keys than the author himself, for more than anybody else he was responsible for our present thorough knowledge of chœtotaxy of Indian larvæ.

Naturally, the characters employed in the keys are absolutely diagnostic and are also very easy to examine. The main table is

amply illustrated by clear diagrams and by cleverly keeping all letter press to only odd pages and by grouping the appropriate illustrations on the opposite pages, the value of the illustrations has been very much increased.

Besides the main synoptic tables, the bulletin contains an introductory section in which brief hints are given on collection, preservation and examination of larvæ, and a concluding section giving notes on some additional diagnostic features and breeding habits of all the species. The fact that in this fourth edition, no major changes were found necessary at all, except the inclusion of the newly discovered differential characters of *A. subpictus* and *sundaicus* shows that the characters used in the keys are well chosen and have stood the test of critical use by several workers.

One comment may, however, be made. Is it any longer necessary to include the five regional tables? For instance, the two tables relating to Peninsular India, and Assam, Burma, etc., each have 34 and 30 species respectively out of the 42 species contained in the main table, and the descriptive matter relating to them is almost an exact repetition in all of these tables. Further, any new worker using the regional tables would any way have to refer back to the pages of the main table to consult the excellent illustrations. Regional keys would no doubt be useful, but they must be limited to very localized areas, doing which is obviously impossible in a work like this. For instance, at Pattukkottai, in South India, not more than 12 species have been met with, while the regional table for Peninsular India contains 34 species and it is as easy for any one to consult the main table as to consult the regional one. It would, of course, always be necessary to include, as has been done, complete lists of all species occurring in particular provinces.

One of the most useful and indispensable handbooks for malaria workers in India.

T. R. R.

The Sugar Technologists' Association of India, Cawnpore, *Year Book*, 1940–41.

This useful Annual reviews the working of the Indian cane sugar factories publishing their names, manufacturing returns, recovery graphs and a synopsis of the figures for comparison. Data relating to milling and other machinery of the reporting factories and a list of cane sugar factories and refineries are appended.

Out of 151 factories which operated during the year, only 74 sent their manufacturing returns. The season was short this year, with 113 working days as against 139 days in the previous year. The quality of cane was slightly better than in the last year; the average pol per cent. cane was 12·18 in 1940–41 as against 11·72 reported in 1939–40. The production of sugar is estimated at 10,82,500 tons this year with a recovery of 9·75 per cent. of the cane as against 9·37 per cent. in 1939–40. Factories also showed marked improvement in milling efficiency, recoveries being highest in February and March.

The average milling efficiency was 91·2 per cent., boiling house recovery, 87·2 per cent. and overall recovery 79·5 per cent. of the sugar in the cane. But till these figures are improved to M.E. = 95 per cent., B.H.R. = 90 per cent., O.R. = 85 per cent., sugar factories in India will be far behind those in other countries, in efficiency. With an average fibre content of 16·1 per cent. cane, extra fuel used as coal and wood have been 0·5 per cent. and 2·8 per cent. of cane. Attempts should be made to send dry bagasse to the boilers, when the need for extra fuel would gradually disappear.

Some factories especially in east U.P. have shown very good results while others in South India and States lag behind. "The necessity for improvements should be realised by owners and technical staff."

In order that the industry should reach a high degree of efficiency, it is essential that an equal if not more attention be paid to the growth, harvest and transport of sugarcane.

An improvement in the quality of cane and its harvesting at the proper time is of more consequence than even improvements in the factory. The chemical staff should be able to help in the field too.

The *Year Book* would be complete with a sugarcane map of India with a table of acreages and harvests.

Y. K. RAGHUNATHA RAO.

THE FORMATION AND THE RECLAMATION OF THUR LANDS IN THE PUNJAB

The Formation and the Reclamation of Thur Lands in the Punjab. By M. L. Mehta. (Research Publication of the Punjab Irrigation Research Institute). Pp. 52 and 17 plates. Price Re. 1–1–0.

LARGE tracts of land in the Punjab are being thrown out of cultivation every year, as a result of continual deterioration of land due to thur. In the Rechna, Chaaj and Bari Doabs, during the years 1927 to 1937, over 5 lakhs of acres of cultivated land went out of cultivation; the present rate of deterioration is about 25,000 acres per year, and taking the worth of an acre at Rs. 200, every year there is a loss of about half a crore of rupees.

In large areas of the Punjab there is invariably a salt-bearing layer of soil some distance below the natural surface, salts being usually present as zones of accumulation in the irrigated areas, with a more uniform distribution of salts in unirrigated areas. Where thur should develop as a result of the irrigation of an area having a salt layer in its profile, the obvious source of the salt is the salt layer. A rising water-table touching a soil crust of 10 or more feet thick, ceases to rise and at the soil surface there are no signs of water-logging. When water-table reaches a depth of about four feet from the surface loss of water by evaporation does not take place and hence a deeper water-table is unlikely to contribute salts to the soil surface. In areas of high water-table, still under cultivation, there are zones of salt accumulation and in lands gone out of cultivation due to thur, much more salt is found than could be ascribed to the water-table as its source indicating that even in areas of high water-table, it is not a very contributory element to thur formation. In the Punjab, the main salt present in the soil is sodium sulphate, which during winter nights, when humidity and temperature conditions are very suitable, absorbs considerable quantities of moisture from the atmosphere and by day, conditions being suitable for evaporation, a moisture gradient is established in the soil with the consequent movement of salt towards the surface. In the *kharif* season, conditions not being favourable, no such movement of salt takes place.

On all the branches of the Lower Chenab Canal, where thur is on the increase, the intensity of irrigation during *kharif* has increased, the depth of water used for irrigating *kharif* crops has decreased from 4·6 feet in 1907 to 2·5 feet per acre in 1936. Investigations carried out in the Punjab Irrigation Research Institute have shown that in *kharif*, salts are either stationary or have a downward movement, an upward movement of salts occurring only in the *rabi* season. Occurrence of thur under the present delta indicates that the upward movement of salts is predominant, resulting in zones of accumulation of salts near the surface, with the consequent transformation of land into thur at all places where these zones are sufficiently near the surface, for a concentration of salt to take place by evaporation. Increase of *kharif* irrigation and decrease in the amount of water used per acre have thus tended to an increase in the area going out of cultivation.

Soil deterioration takes place in two stages, the first stage consisting of an accumulation of salts, the second of the alkalisation of the soil. In normal soils clay is mainly present as calcium clay which when brought into contact with a solution of sodium sulphate or sodium chloride is transformed to an alkaline sodium clay. The longer the land is left unreclaimed, the greater will be the development of alkalinity rendering reclamation difficult and ultimately economically impossible. In a very alkaline soil, clay becomes deflocculated and the soil impermeable to water leading to difficulties in leaching and rendering the soil unsuitable for growth of normal crops.

Soils having a soluble salt content of 0·2 per cent. or less and a pH value not

higher than 8·5 were found to be capable of growing normal crops and giving normal yields; when the pH value lay between 8·5 and 9·0, land could be reclaimed with one rice crop followed by berseem, or senji, sugarcane and wheat or cotton, when the pH value lay between 9·0 and 9·5, two rice crops could reclaim such lands. When the salt content is over 0·2 per cent. but the pH value is less than 9·00 the soil is known as 'thur' and a rice crop reclaims the soil, gram, berseem, and senji can be grown in the *rabi* and sugarcane or cotton in the following *kharif*. When the pH value is greater than 9·5, with or without high salt content, the soil is known as 'rakkar' soil and reclamation of this soil is not economical. It is advisable to exclude such 'rakkar' soils from reclamation or new irrigation projects.

Land to be reclaimed is divided into ¼-acre-plots with the main water-course running through the middle of the field. Water is made to stand in the fields to a depth of four inches, from the first week of April to about the beginning of May. Field drains or means for pumping drainage water are provided in areas where the water-table is about 6 feet from the surface. 'Sathra' variety of rice is grown on fields where there has been rapid percolation and salts have been washed down. The 'Sathra' variety of rice was also found to fit in well, in areas where there is limited water supply. 'Sathra' does not require irrigation after the 10th July and other fields which have been under leaching are planted about this time with either the 'Sathra' or the 'Jona' variety of rice followed by hemp, gram, berseem or senji. Nearly 50 acres of 'thur' land can be reclaimed on one cusec of water. Leaching is very rapid in soils where the salt content is high and alkalisation is low. Though the reclamation is more easily effected, as water does not sufficiently stand in the rice fields, the yield of rice becoming low reduces the profit on reclamation. To obtain normal yields of rice under these conditions and to limit the water used to that required for actual removal of salts, the *barani* hill varieties of rice, requiring less water are introduced in such areas.

Yields of rice from reclaimed area were found to be higher than yields from normal soils in the neighbourhood and yields of rice even seven years after reclamation were found to be above normal. It was calculated, from a scheme for commercial reclamation, based on the work at Chakanwali Reclamation Farm and on seven years' 'data' in Zemindar's fields, that, if prior to reclamation land was worth Rs. 80 per acre, its value after reclamation would rise to Rs. 200 per acre. The total expenditure on three years, on reclamation in an area of 25 acres of thur land was found to work out to Rs. 1,872, the income during the period being Rs. 2,669.

Experiments have conclusively shown that salts can be removed from the soil, by the growth of rice and the land so reclaimed can produce good crops of cotton, wheat or sugarcane well over a period of 7 to 8 years without exhibiting any signs of deterioration. But it is essential to mark out at the outset, deteriorated or danger zones, and apply to such areas what Dr. McKenzie Taylor terms the 'Basin System of Irrigation' which washes out the salts to the underlying sand layers. It is also found from the available evidence that rice need be introduced only at long intervals of nine years or more.

The Punjab Province is greatly indebted, as Mr. Mehta observes at the very commencement of the paper, to Dr. McKenzie Taylor for all his guidance in the experimental work and for the evolving of methods for permanent reclamation of deteriorated lands and the development of new project areas.

C. GOPALAKRISHNAN.

CENTENARIES

Birkbeck, George (1776-1841)

GEORGE BIRKBECK, the founder of the Mechanics Institute, was born at Settle, Yorkshire, January 10, 1776. He received the rudiments of education at a village school. He displayed an early predilection for mechanical and scientific subjects, which led him to select the medical profession and he became an M.D. of Edinburgh in 1799.

In November 1799 he became professor of Natural and Experimental Philosophy in the Andersonian College at Glasgow. There was at that time no maker of scientific instruments and he was obliged to have them made by ordinary workmen. He had employed a tinman to construct a model of a centrifugal pump. While surrounded by the workmen in the cellar which was the workshop, he was struck with the idea of giving a course of lectures for the scientific instruction of mechanics. In March 1800 he communicated his wishes to the trustees of his College, who regarded the proposal as visionary!

Hence, at the close of 1800, he himself took the initiative and circulated a printed invitation in the chief manufacturies of the town, offering free lectures. The number who accepted this offer was at first not large and the first lecture was attended only by 75 persons. But it gave so much satisfaction, that the number exceeded 500 in the fourth lecture. This was the beginning of the education of mechanics.

In 1800 Dr. Birkbeck settled in London. While he developed a lucrative practice, he did not lose his interest in popular education. In 1820, he gave a free course of evening lectures and in 1823 he took part in the foundation of the London Mechanics Institute, which was later named after him. He was the president of this school till his death.

Birkbeck died at his residence in Finsbury Square December 1, 1841.

Don, David (1800-1841)

DAVID DON, a Scottish botanist, was born at Forfar in Scotland, December 21, 1800. His father was in charge of the botanical garden at Edinburgh, and this led David to acquire a considerable knowledge of botany even while young. In 1819 he was employed as librarian and curator by Mr. Lambert of London who had at that time a large collection of plants.

One of his earliest publications was *Description of several new or rare native plants found in Scotland chiefly by the late Mr. George Don of Forfar.* He followed this up by several papers contributed to the *Transactions* of the Linnæan Society. His accurate description of plants earned him a reputation and in 1822, he was appointed librarian of the Linnæan Society and he was appointed professor of botany in the King's college in 1836.

As librarian of the Linnæan Society, he used his opportunity to make considerable contributions to the *Transactions* of the Society and his papers number as many as 52. He was particularly attracted by the collection of Indian plants and in 1825 he published a description of the plants of Nepal under the title *Prodromus floræ Nepalenses.*

Though his constitution was strong and robust, he developed a malignant tumour on his lip, of which he died eventually, December 8, 1841.

University Library, Madras. S. R. RANGANATHAN.

SCIENCE NOTES AND NEWS

Activity Coefficients of Reducing Agents.—In a series of papers on the 'Thermodynamic study of bivalent metal halides in aqueous solutions', Stokes and Robinson (*Trans. Far. Soc.*, 1941, 37, 419) have described a simple modified form of apparatus for using isopiestic method to determine the activity coefficient of ferrous chloride using an inert atmosphere to prevent the oxidation of the salt. The special feature of this method is that the apparatus can be employed even for the preparation of ferrous chloride starting from iron and hydrochloric acid, thus preventing the oxidation completely. It has been found that the activity of ferrous chloride occupies a regular position in the series: manganese, iron, cobalt and nickel chloride. M. R. A.

Investigations on the Cold Storage of Potatoes.—One of the major problems connected with the cultivation of potatoes in India relates to the storage of the tubers over the fairly long period of dormancy required by them before they can be used for seed. As is well known the potato has to be kept for some two and a half to four months (depending upon the variety, the stage of maturity, and the season of the year) and then alone used for planting. Very large quantities of ordinary table potatoes also have to be stored likewise for varying periods in order to avoid a slump in the market and to obtain the higher prices which rule later in the season. A good deal of loss due to storage pests, dry and wet rots and driage takes place during such storage and

in the present methods of storage, more or less at the atmospheric temperature, which are known to and practised by the cultivator this loss is very high; in the summer months especially the loss is much higher still and is almost ruinous. The loss is seldom less than 25 to 30 per cent. and is known to go up as high as 80 per cent. Tubers stored for use as table potatoes begin to germinate and suffer in quality, adding thereby to the other losses.

The possibility of keeping potatoes under cold storage in India and the conditions of temperature most suitable for this purpose have been the subject of special investigation by the Imperial Council of Agricultural Research at the cold storage plant specially put up for the purpose at Kirkee and the results obtained during the last three years from 1936–39 have now been published (Karmarkar and Joshi in *Misc. Bull.*, No. 45 of the I.C.A.R.). The following are the important conclusions: (1) Potatoes can be kept without sprouting at 35° F. almost indefinitely. At temperatures higher than 35° F. potatoes begin to sprout; at 40° F. they remain dormant for varying periods, the length of which depends on the time that elapses from harvest to storage; for instance if the tubers are put in immediately after harvest they can remain dormant for quite nine months. At 35° F. and 40° F. the tubers remain in sound condition without any kind of rotting. Lower temperatures of 30° F. and 32° F. bring about "black-heart" disease with a characteristic hollow cavity in the interior of the tuber. (2) The germinating power of the tubers is not impaired by cold storage at 35° F. and 40° F. Such tubers sprout vigorously when removed to 68° F. without any rot setting in. (3) Losses in weight due to driage are largely reduced; at 35° F. and 40° F. the loss of tubers stored in crates or gunny bags was only five per cent. after five months at 40° F. and after nine months at 35 ° F. (4) In potatoes stored at 30° F. and 35° F. there is a marked accumulation of sugars so that the tubers become sweet and to that extent suffered in quality as table potatoes. If removed to 68° F. the tubers lost some of this sweetness and therefore somewhat improved in quality.

It will thus be seen that cold storage can be used as a very efficient method as far as seed potatoes are concerned, while in respect of table potatoes it has the drawback of impairing the quality to some extent. Such as they are the results are of great and undoubted practical value. There are now cold storage facilities in many large potato centres such as Jammu, Karachi, Meerut, Patna and Sialkot, and a knowledge of these results should lead to a larger use of these facilities by seed potato merchants.

A. K. Y.

Infantile Cirrhosis of the Liver.—An important paper on the ætiology, pathology and morbid anatomy of the liver in infantile cirrhosis, has appeared in the *Proc. Ind. Acad. Sci.* (1941, 14, 310). According to the author there are two factors in the ætiology of the disease: cow's milk and *B. coli* infection. Cow's milk brings about the predisposing factor, *viz.*, gastro-intestinal disorder and devitalization of the liver and *B. coli* the cirrhotic changes in the liver. In support of the view that *B. coli* is the causative agent, the author states that (1) smears of liver substance show the presence of gram negative bacilli morphologically identical with *B. coli*, (2) cultures made from the scrapings of the liver substance show the presence of *B. coli communis*, (3) cultures of urine in 4 cases have shown the growth of *B. coli*, and (4) vaccine prepared out of *B. coli* grown from the fæces of children suffering from infantile cirrhosis and inoculated in successive increasing doses over a period of 6–7 weeks, has cured the disease.

Quality of Hides and Skins.—Under the auspices of the Imperial Council of Agricultural Research, attempts are being made to improve the quality of hides and skins by preventing the damage caused by warble flies and ticks and by improving the methods of flaying and curing. Warble fly is prevalent, especially in the drier tracts of Northern India, and even at a conservative estimate the annual monetary loss to the whole country due to small permanent holes in the skin caused by the grubs while escaping to the exterior from warble tumours on the back, is about Rs. 1,50,00,000.

The life-history of the ox warble fly has been completely worked out under Indian conditions at the Imperial Veterinary Research Institute, Muktesar, and the preliminary results of the work carried out in collaboration with the Civil Veterinary Department, Punjab, on evolving effective and cheap control measures by preventive and dressing methods in the field appear to be promising.

Similar work on goat warble fly prevalent especially in hilly tracts is also in progress. A study of the various ticks, their life-history, damage caused by them to hides and skins and their control by biological methods, and suitable dips at appropriate intervals are also being taken up at the Imperial Veterinary Research Institute with the Council's assistance.

Work carried out so far in the Bombay Presidency under another scheme financed by the Council, has shown that cattle dips prove useful in controlling the ticks and tick-borne diseases and thereby improving the condition of the animals and the hides. A scheme has been approved by the Council for establishing village flaying centres in the North-West Frontier Province in order to improve the flaying and curing of hides.

Quality in Wool and Sheep Breeding.—A number of co-ordinated schemes of sheep breeding financed by the Imperial Council of Agricultural Research are in progress in various Provinces and States, namely, Punjab, Bombay, Madras, Bihar, Mysore and Kashmir.

The sheep are graded and selected for breeding on the basis of the quality of wool and in order to do this an analytical laboratory is being added to each field station, and a special laboratory, to work in consultation with the woollen industry, has been provided at the Bombay University.

A scheme has recently been approved by the Advisory Board for the establishment of village shearing and grading centres in the North-West Frontier Province in order to demonstrate to and popularise among the village shepherds washing of sheep before clipping, improved methods of shearing and classification of wool.

A scheme for the establishment of a Central Wool Research Station at the Imperial Veterinary Research Institute, Izatnagar, has also been under the consideration of the Council for some time. There is unanimity of opinion that early establishment of such a guiding and correlating organization is essential for the scientific improvement and development of the wool industry in this country. The Advisory Board of the Council has, therefore, strongly recommended to the Government of India to finance this scheme as early as possible.

New Uses for Jute.—According to a press note dated November 20, issued by the Indian Central Jute Committee, Mr. D. L. Mazumdar, I.C.S., Secretary, Indian Central Jute Committee, recently visited the Lac Research Institute of the Indian Lac Cess Committee at Namkum (Ranchi), and discussed with Dr. H. K. Sen, the Director of the Institute, the possibilities of extending the use of jute.

Two promising lines of investigation received particular attention, *viz.*, the use of jute cloth in combination with jute waste for the manufacture of cheap laminated boards and other similar purposes, and the treatment of jute fibre with suitable solutions of shellac resin as a basis for the manufacture of different types of 'proofed' material.

The application of synthetic plastics to jute is another allied and very important line of investigation which is already receiving the attention of the Central Jute Committee. Consultations with Dr. Sir S. S. Bhatnagar of the Board of Scientific and Industrial Research on this subject are already in progress, and a detailed scheme of work is likely to be formulated in the very near future.

Progress of Higher Education in British India.—The total number of arts colleges in the whole of British India, both for men and women, rose from 289 in the previous year to 304 in 1939–40 according to the latest survey of progress of education in British India. The number of men under instruction rose from 100,770 to 109,921, showing an increase of 9,151. In the case of women, scholars in arts colleges in the previous year numbered 7,976 and in 1939–40 they were 9,615, showing an increase of 1,639.

The number of professional colleges increased by two, from 79 in 1938–39 to 81 in 1939–40. The total number of men under instruction also went up by 1,593 and of women by 92.

The total educational expenditure in 1939–40 was Rs. 29,08,76,000 as compared with Rs. 27,81,99,000 during the previous year. The share of public funds in the increased expenditure was to the extent of Rs. 79,17,000, of fees Rs. 46,35,000 and of other sources, which include private benefactions, Rs. 1,25,000.

Coal Mines Stowing Board.—The annual report of the Board for the year 1940–41 which has been recently published, gives an account of the way in which the work of the Board has been organised to fulfil the functions assigned to it, according to the Coal Mines Safety (Stowing) Act of 1939—particularly the granting of assistance from the funds for the following purposes: (i) for stowing or other protective measures which are required to be undertaken by an order issued by the Mines Department under Section 9(3) of the Act, (ii) for any protective measures essential for the effective prevention of the spread of fire to, or the inundation by water of, any coal mine from an area adjacent to it, (iii) for stowing operations voluntarily undertaken in the interests of safety, and (iv) for research connected with safety in mines. The first problem which engaged the attention of the Board was that connected with the fire areas in the Jharia coal field, and a number of protective measures have already been adopted in these areas. As many as 68 applications were received from a number of companies for financial assistance from the Board, and a special *ad hoc* expert technical committee was appointed to deal with them.

Department of Fisheries (Hyderabad State).—A three-year scheme for the development of the Fishery Resources of the State, has recently been sanctioned by the Government. The services of a Zoologist from the Osmania University, who has since undergone training in the Madras Fisheries Department, have been obtained for starting this Department. He is assisted by four technical assistants.

During the initial stages, the work will be largely exploratory. The following problems are now engaging the attention of the research staff: (1) Fish survey of the main rivers and tanks, (2) Possibilities of establishing fish farms and hatcheries for the breeding of useful fishes and prawns, and (3) Problems of transport and marketing of fish and prawns.

Indian Chemical Manufacturers Association.—The third annual meeting of the Indian Chemical Manufacturers Association was held in Bombay on the 19th and 20th September 1941. The first two annual meetings were held in Calcutta and it is a matter for gratification that the venue was changed this year. It is to be hoped that next year's meeting will be held in Madras or some other South Indian city. The session was presided over by Raj Mitra B. D. Amin, the outgoing President of the Association. As usual, a number of

resolutions were passed, most of them unanimously, on subjects of importance to the Indian Chemical Industry such as excise regulations, the refusal of the Government to permit opium alkaloids to be manufactured by private firms, the activities of the Government Medical Stores Depots, the heavy railway freight on raw drugs and medicines, the failure of the Government to appoint a representative of the Indian Chemical Manufacturers on the Drugs Technical Advisory Board, etc. The efforts of the Association deserve better success than they have had hitherto; so far it has been chiefly a cry in the wilderness, though a very loud and persistent one.

Under the auspices of the Association, a conference of manufacturers and representatives of universities and research institutions was held under the presidency of Dr. Jivraj Mehta with the object of considering steps to secure closer co-operation and collaboration between manufacturers and research institutions. After some discussion a sub-committee was appointed to recommend suitable steps to be taken to further the objects of the conference.

Mr. J. N. Lahiri of the Bengal Chemical and Pharmaceutical Works was elected President of the Association for the year 1941–42. The membership of the Association has been increasing steadily and its usefulness is growing.

SEISMOLOGICAL NOTES

During the month of November 1941 three great, four moderate and six slight earthquake shocks were recorded by the Colaba seismographs as against one great, one moderate and six slight ones recorded during the same month in 1940. Details for November 1941 are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
November 1941		H.	M.	(Miles)		(Miles)	
5	Moderate	23	9	3430	Lat. 10°·5 N., Long. 124° E., near Leyte in the Philippine Islands.		
6	Slight	12	36	5230			
9	Great	5	8	3550	Lat. 5°·5 N., Long. 124° E., near Mindanao, Philippine Islands.		
9	Slight	15	27	1360			
12	Slight	12	21	1710	Lat. 6° N., Long. 95° E., in the neighbourhood of Sumatra.	60 (approx.)	
12	Slight	15	35	2500			
18	Great	22	17	3750	Lat. 32°·3 N., Long. 133° E., within 100 miles to the south of the island of Shikoku, Japan.		
21	Slight	1	25	1490	South of the Andaman Islands.		
24	Slight	22	7	4550			
25	Moderate	3	20	7250			
25	Great	23	34	5370	Lat. 43° N., Long. 19° W., in the Atlantic Ocean to the northwest of Portugal.		Felt in Portugal.
27	Moderate	14	8	3590		190 (approx.)	
28	Moderate	17	53	1280	The Hindukush Mountains.	125 (approx.)	Felt in Peshawar.

MAGNETIC NOTES

November 1941 was more active than the previous month. There were 13 *quiet* days, 13 days of *slight* disturbance and 4 of *moderate* disturbance as against 7 quiet days, 15 days of slight disturbance and 8 of moderate disturbance during November 1940.

The day of largest disturbance during November 1941, was the 28th when a moderate disturbance was recorded. The quietest day was the 14th. The characters on individual days were as follows:—

Quiet days	Disturbed days	
	Slight	Moderate
2, 4, 12–16, 20, 21, 24–26, 30	3, 5,7–11, 18, 19, 22, 23, 27, 29	1, 6, 17, 28

Only one moderate disturbance was recorded during November 1941, as against three moderate storms in November 1940. The mean character figure for November 1941 was 0·70 as compared with 1·03 for the same month last year.

M. R. RANGASWAMI.

ASTRONOMICAL NOTES

The Earth will be in perihelion at 0^h 30^m I.S.T. on January 3, 1942.

Planets during January 1942.—Venus continues to be a brilliant object in the western sky in the early part of the night; it will be gradually approaching the Sun and on January 11 will be at a stationary point of its geocentric orbit. Mercury will likewise be an evening star, but can be seen only during the latter half of the month, low down near the western horizon at about sunset; it reaches greatest elongation from the Sun (18° 31′ E.) on January 25. Mars is moving slowly eastwards in the constellation Aries and will be near the meridian at sunset; its brightness is steadily decreasing and will be little more than that of an average first magnitude star by the end of the month.

Both Jupiter and Saturn are conspicuous objects in the eastern sky in the early hours of the night and will be on view until their setting about a couple of hours after midnight. The ring ellipse of Saturn is now seen fairly widened, the angular dimensions of the major and minor axes being 43″·5 and 16″·8 respectively. Uranus continues to move slowly in a retrograde direction in the constellation Taurus about six degrees to the south east of the star cluster Pleiades. There will be a very close conjunction of Neptune with the Moon on the night of January 8; an occultation of the planet will occur at about moonrise that night which will be visible wholly or in part in this country, but a binocular or a small telescope will be necessary to observe the phenomenon.

T. P. B.

ANNOUNCEMENTS

The Indian Statistical Conference.—The Fifth Session of the Indian Statistical Conference will be held at Baroda during the first week of January 1942, in co-operation with the Indian Science Congress. His Highness the Maharaja Gaekwad of Baroda has kindly agreed to open the Conference at 9-30 A.M. on 3rd January 1942. There will be discussions and reading of papers in different branches of theoretical and applied Statistics, and it is hoped that joint meetings with allied sections of the Science Congress will also be arranged.

The Government of India, the different Provincial Governments, many of the important Indian States and Universities in India have given official recognition to the Conference and are expected in many cases to send delegates. Enquiries in regard to local arrangements and accommodation should be addressed to Mr. A. C. Mukherji, Director of Statistics, Baroda.

Indian Statistical Institute.—In accordance with a resolution adopted at the fourth Indian Statistical Conference, held at Benares on the 4th January 1941, a questionnaire has been circulated to statisticians all over the country, with a view to invite suggestions on the organisation of statistical education in India on a really comprehensive and systematic manner. "In the questionnaire attempts have been made to focus attention on the aims and requirements of statistics with a view to organise the teaching of statistics in its present setting and with an eye to its future development. Among other things also, the question of opportunities of useful employment of statisticians by Government and other institutions has been considered."

It is proposed to present an analytic summary of the replies received at the Fifth Session of the Indian Statistical Conference to be held during the first week of January 1942, at Baroda, for further consideration. Persons interested in the subject are invited to participate in the discussion.

Lucknow University.—Programme of Science Lectures for the Winter Session (1941–42):—

January 9 and 10.—Prof. S. R. Bose, D.SC., F.R.S.E., "The Polyporaceae: (*a*) Anatomical and cytological studies. (*b*) Physiological studies."

January 12 and 13.—Dr. B. Mohan, M.A., PH.D., "Self-reciprocal functions".

January 16 and 17.—Dr. R. S. Varma, D.SC., "Recent developments in the theory of integral functions".

January 23 and 24.—Dr. Ram Behari, M.A., PH.D., "Differential geometry of ruled surfaces".

January 30 and 31.—Dr. A. C. Chatterji, D.SC., DR.ING., "Supersaturated solutions".

February 4 and 5.—Dr. A. N. Singh, D.SC., "The problem of integration".

February 7.—Prof. N. N. Sen Gupta, M.A., PH.D., "Dimensional conception of mental life".

February 14.—Mr. S. B. L. Mathur, M.SC., "Halo or corona—a problem in optical meteorology".

February 18 and 19.—Dr. D. N. Majumdar, M.A., Ph.D., "Blood Groups: (*a*) Distribution of blood groups in India. (*b*) Blood groups of criminal tribes in the United Provinces".

February 22 and 23.—K. Ramiah, "Plant breeding and genetics in India".

Indian Research Fund Association.—The attention of our readers is drawn to an advertisement appearing elsewhere in this issue, inviting applications for five Research Fellowships of the value of Rs. 150 each per mensem under the Indian Research Fund Association. Applications should reach the Secretary, I.R.F.A., Secretariat, New Delhi, not later than 7th February 1942.

Erratum.—*Vol.* 10, *No.* 11, *Nov.* 1941: Note entitled "Industrial Research Fund," page 483, second column, line 14, *for* "prominent" *read* "permanent".

We acknowledge with thanks, the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 89, Nos. 4595–96.
"Journal of Agricultural Research," Vol. 63, Nos. 2–3.
"Agricultural Gazette of New South Wales," Vol. 52, Pt. 10.
"Indian Journal of Agricultural Science," Vol. 11, Part 5.
"Biochemical Journal," Vol. 35, Nos. 5 and 6.
"Journal of Chemical Physics," Vol. 9, No. 10.
"Journal of the Indian Chemical Society," Vol. 18, No. 8.
"Experiment Station Record," Vol. 85, No. 3.
"Electrotechnics," No. 14, Nov. 1941.
"The Indian Forester," Vol. 67, No. 12.
"Transactions of the Faraday Society," Vol. 37, No. 9.
"Indian Farming," Vol. 2, No. 11.
"Geological, Mining & Metallurgical Society of India, (Jl.)," Vol. 13, No. 2.
"Bulletin of the Health Organisation (League of Nations)," Vol. 9, No. 3.
"Review of Applied Mycology," Vol. 20, Pt. 9.
"Bulletin of the American Meteorological Society," Vol. 22, No. 7.
"Journal of Nutrition," Vol. 22, No. 4.
"Nature," Vol. 148, Nos. 3748–52.
"Philippine Journal of Science," Vol. 75, No. 5.
"Journal of Research (National Bureau of Standards)," Vol. 27, No. 3.
"Canadian Journal of Research," Vol. 19, No 8.
"Sky," Vol. 5, No. 12.
"Science and Culture," Vol. 7, No. 6.
"Indian Trade Journal," Vol. 143, Nos. 1847-50.

Books

"The Ecology and Control of the Forest Insects of India and the Neighbouring Countries," by C. F. C. Beeson. (Forest Research Institute, Dehra Dun), 1941, pp. ii + 1007.

"Galois Lectures" delivered by Jesse Douglas, Philip Franklin, Cassius Jackson Kenyser and Leopold Infeld. (Scripta Mathematica, New York), 1941, pp. 124, price $1.25.

"An Introductory Course in Quantitative Pharmaceutical Analysis," by M. L. Schroff. (Indian Pharmaceutical Association, Benares Hindu University), 1941, pp. x + 312, price Rs. 4 or $1·75.

"An Introduction to Semi-Micro Qualitative Analysis," by M. L. Schroff and G. P. Srivastava. (Indian Pharmaceutical Association, Benares Hindu University), 1941, pp. x + 203, price Rs. 3 or 5*sh.*

"Plant Science Formulæ," a reference book for Plant Science Laboratories (including Bacteriology), by R. C. McLean and W. R. Ivimey. (Macmillan & Co., London), 1941, pp. vii + 203, price 7*sh.* 6*d.*

"Diffusion in and through Solids," by Richard M. Barrer. (Cambridge University Press, London), 1941, pp. xiii + 464, price 30*sh.*

"The Applications of Chemical Engineering," Edited by Harry McCormack. (Chapman & Hall, London), 1940, pp. x + 431, price 21*sh.*

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

November 1941. SECTION A.—Sir C. V. Raman: *The thermal energy of crystalline solids: Basic theory.* The bulk of the thermal energy is associated with the lattice frequencies properly so-called which appear as monochromatic lines in the infra-red spectrum. The residue is associated with superlattice frequencies of different orders which are also monochromatic. These frequencies appear in the remote infra-red region and their contribution to the specific heat is relatively important only at low temperatures. The spectroscopic evidence is in full accordance with these ideas. The specific heat theories of Debye and Born are based on assumptions which are theoretically unjustifiable, and in contradiction with the experimentally observed behaviour of crystals. R. Norris: *The thermal energy of crystalline solids: White phosphorus.* Bisheswar Dayal: *The thermal energy of crystalline solids: Lithium, tungsten, gold, silicon and grey tin.* V. B. Anand: *The thermal energy of crystalline solids: Diamond.* Experimental studies have shown that the lattice spectrum of diamond consists of monochromatic frequencies down to much below the limiting frequency of Debye. Excellent agreement is obtained between the spectroscopic values and the experimental data throughout the temperature range covered by Pitzer and indeed precisely in the region where the values given by the Debye formula show the largest deviations from the observed ones. Bisheswar Dayal: *The thermal energy of crystalline solids: Magnesium, zinc and cadmium.* R. Norris: *The thermal energy of*

crystalline solids: Quartz. C. S. VENKATESWARAN: *The thermal energy of crystalline solids: Alkali halides.* A general expression is derived for the thermal energy of cubic crystals of the rock-salt type in terms of the lattice and superlattice frequencies and evaluated for rock-salt and sylvine. Calculated values are in reasonable agreement with the experimental data. R. D. DESAI, R. F. HUNTER AND G. S. SAHARIYA: *Studies in the cyclohexane series. Part V. The isomeric* 1-*carboxy*-4-, *and* 3-*Methylcyclohexane*-1-*a*-*benzylacetic acids.* K. V. KRISHNA RAO: *Raman spectrum of mercuric chloride in relation to its structure.* $HgCl_2$ should be non-polar and therefore a linear molecule. K. VENKATESWARLU: *Effect of temperature on the intensities of Raman lines. Part I. Crystals.* Sharp disagreements with the existing theories have been noticed in the matter of the individual intensities of the Stokes and the anti-Stokes lines at different temperatures, but the observed ratio of the intensity of the Stokes lines to that of the anti-Stokes lines conforms to the present theories. HIRALAL SHRIVASTAVA: *Physico-chemical studies with aqueous fluoride solutions. Part I. The decomposition and discharge potentials of some fluorides in aqueous solution.* S. RANGASWAMI AND T. R. SESHADRI: *Fixation of aromatic double bonds.* BAWA KARTAR SINGH AND SAILESH CHANDRA SEN: *The kinetics of the mutarotation of aminomethylene*-d-*camphor.* HIRA LAL DUBE AND SATYA PRAKASH: *Kinetics of sol-gel transformation. Part V. The influence of different coagulating electrolytes on the setting of ferric phosphate gel.* S. RAMACHANDRA RAO AND MISS K. SAVITRI: *Magnetism of strontium.* G. V. L. N. MURTY AND T. R. SESHADRI: *Raman effect and hydrogen bonds. Part I. Mixtures of esters and acceptor molecules.* Hydrogen bond formation between various esters as donor molecules and phenol, alcohols, and chloroform as acceptor molecules has been studied. There are large variations in the strengths of the hydrogen bonds.

SECTION B.—P. N. KRISHNA AYYAR: *The biology and distribution of the parasites of the cotton stem weevil,* Pempheres affinis *Fst. in South India.* B. G. L. SWAMY: *The development of the male gamete in* Cymbidium bicolor *Lindl.* M. J. THIRUMALACHAR AND K. BASHEER AHMED KHAN: *Megasporogenesis and endosperm formation in* Eriodendron anfractuosum *D.C.* M. J. THIRUMALACHAR: *A new species of puccinia on* Ocimum adscendens. T. S. RAGHAVAN AND A. R. SRINIVASAN: *Cytomorphological features of* Portulaca tuberosa *Roxb.*

Royal Asiatic Society of Bengal:

August 4, 1941.—D. N. MAJUMDAR: *Racial Affiliation of the Gonds.* Anthropometric measurements of about 600 people were taken by the author and the statistical data were analysed with the help of the Statistical Laboratory, Calcutta. The analysis reveals a close correspondence between social units and racial status. The following conclusions have been drawn from the anthropometric survey of Bastar State: (1) The Gonds represent a blended racial type. (2) The higher castes, Dhakars and Halbas of Bastar have freely mixed with the Gond tribes in the neighbourhood. (3) The Hill Marias who are the most primitive cultural group in Bastar differ from the higher caste groups. (4) The Dandami Marias who were originally Hill Marias have come in closer contacts with the higher castes. (5) From a comparison of the head measurements, it appears that there is a progressive lengthening of the head towards the mountain regions.

Society of Biological Chemists (India):

Addressing the *Society of Biological Chemists, India* (Madras Branch), on the 15th November 1941, Dr. Fowler dealt with recent developments in the utilisation of Town's waste for war-time food production, representing a fundamentally important aspect of war effort. The campaign of "The Dig for Victory" directed towards making England self-supporting as far as possible in the matter of food, is now in full swing in that country, and this movement has brought some 2 million acres of fresh land under the plough. To reap the maximum harvest from all this and other agricultural land, the question of fertilisers has first to be considered, and the problem has caused attention to be given to the whole cycle involved, i.e., the land and its fertility, the crop and its quality, the preparation and consumption of food from the crop, and the return of the consequent waste back to the soil.

The waste products of the town—both the liquid and the solid—were now being scientifically treated to yield valuable food producing fertiliser and Dr. Fowler drew attention to an interesting discussion on the whole subject which took place last March before the Royal Society of Arts. In the course of this discussion, the importance of the conservation of the humus of the soil, was emphasised. The formation of humus from organic matter was an aerobic process and this could be speeded up by scientific "composting" which facilitates the process of oxidation. The object of this was to prevent what might be termed "soil indigestion". The potential fertilising material in the compost heap was fermented separately from the soil so that the products of fermentation were at once available to feed the crop.

Dr. Fowler emphasised the importance of organic manures which imparted to the crops a "quality" not obtainable from artificial fertilisers. In support of this contention, the lecturer drew attention to the researches of McCarrison and his colleagues. He pleaded for a thorough and scientific utilisation of waste in India.

1851-41—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the Board of Editors, "Current Science", Bangalore.

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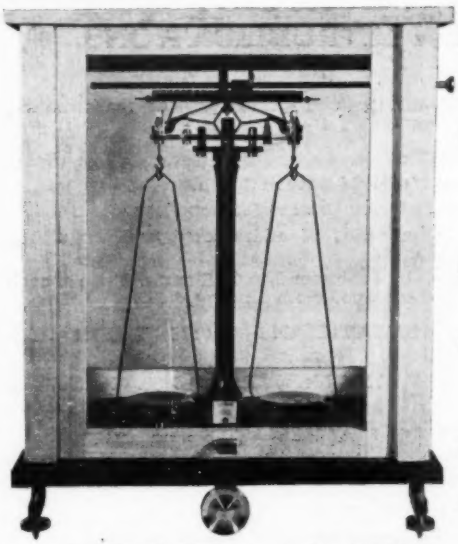

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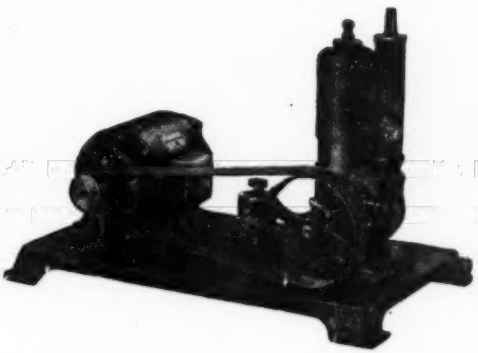

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6. Candidates will be required to furnish the following additional information in their applications :

(*a*) Full name ;
(*b*) Age ;
(*c*) Sex ;
(*d*) Permanent Address ;
(*e*) Details of academic career.

7. Applications, which must be typed, should be addressed to the **Secretary, Indian Research Fund Association, Secretariat, New Delhi,** so as to reach him not *later than the 7th February 1942.*

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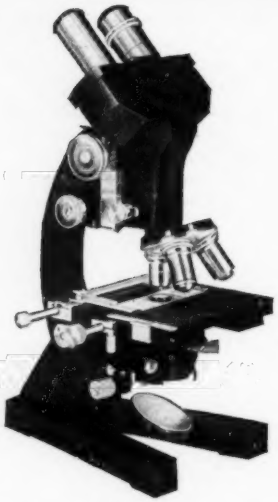

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